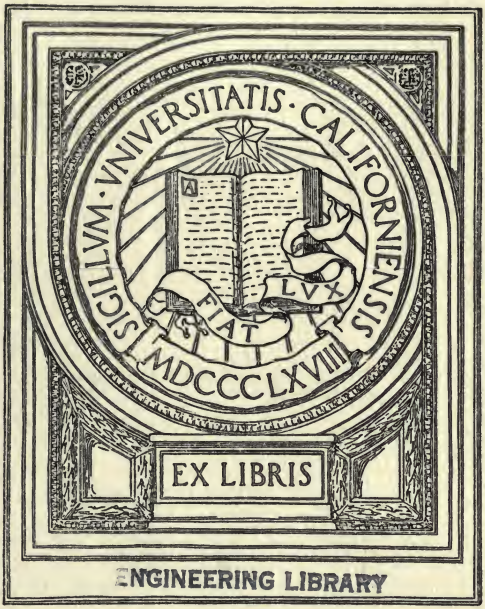
GILBERT

REG. U.S. PAT. OFF.

SIGNAL ENGINEERING

JOHN ALEXANDER JAMESON, Jr.
1903-1934



This book belonged to John Alexander Jameson, Jr., A.B., Williams, 1925; B.S., Massachusetts Institute of Technology, 1928; M.S., California, 1933. He was a member of Phi Beta Kappa, Tau Beta Pi, the American Society of Civil Engineers, and the Sigma Phi Fraternity. His untimely death cut short a promising career. He was engaged, as Research Assistant in Mechanical Engineering, upon the design and construction of the U. S. Tidal Model Laboratory of the University of California.

His genial nature and unostentatious effectiveness were founded on integrity, loyalty, and devotion. These qualities, recognized by everyone, make his life a continuing beneficence. Memory of him will not fail among those who knew him.

GILBERT
SIGNAL ENGINEERING

Complete and thorough instructions
in all forms of Signaling

FOR BOYS

BY

LEE CONOVER
Formerly with Signal Corps U. S. Navy

Prepared under the Direction of

A. C. GILBERT
Yale University, 1909

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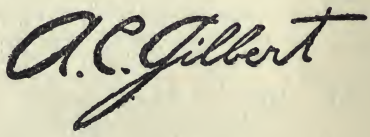
FOREWORD

To do big things, just as men do who are experts in a certain kind of endeavor, I believe is the greatest wish of every boy. I know when I was a boy it was very interesting to me to find out all I could about electricity, chemistry and other practical subjects because they held my attention. There was all kinds of fun in this for me. Whenever I got working on my experiments I had the greatest amount of pleasure. Let me tell you, too, I was a happy boy when I had completed my work and could show it to others.

I remember how I used to watch army men at signal practice. It was mighty fascinating to see them at the camp with their apparatus and to observe the methods they used to send messages. It looked hard, but when I thought it over it seemed very easy.

Signaling will prove just as interesting to you as it did to me, and because I think it means a great amount of fun for you, I have had this book prepared by a man who was an expert in signals and who did very fine work in the Navy as a member of the Signal Corps. Every detail is explained with the greatest care. The facts are authentic and you can depend on this book to give you a thorough knowledge of signaling. You can learn about signals from the very beginning when firebrands were used in a primitive fashion many years ago to the present time when messages are flashed and sent by the most modern inventions.



SIGNAL ENGINEERING

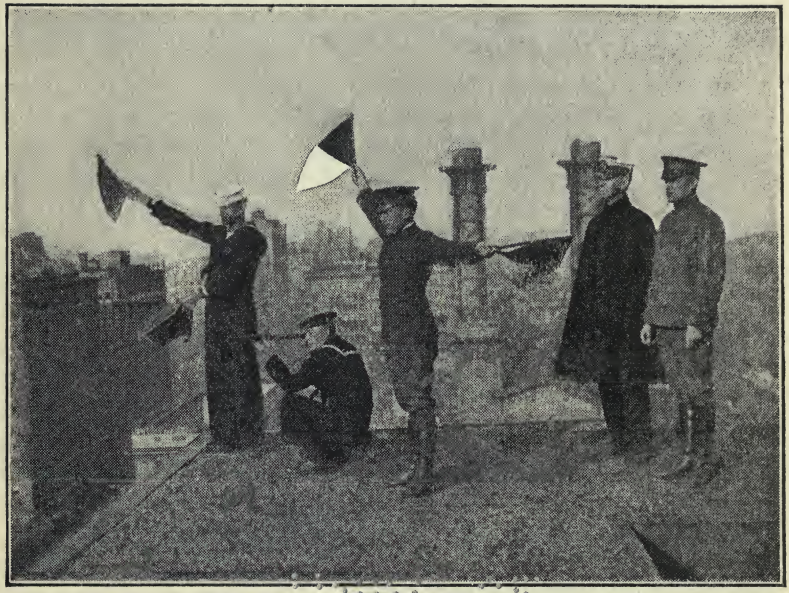


FIG. 1.

Competing teams of the U. S. Army and Navy on the roof of the Grand Central Palace, New York City, during a recent signal contest.

Chapter I

In Webster's Dictionary we find that the meaning for signal is a sign and in looking up sign find its definition to be signaling—hence they are certainly very closely related. At any rate a signalman is one who puts signs into action and that is what we are going to do. By a little perseverance you will master

each lesson step by step and in a very short time, with the ease of a master signalman, be able to flash a message through space for a distance of twenty miles or more.

The early American Indians wrote their picturegraph messages on the bark of trees, their canvas wigwams and other conspicuous places. The totem pole of the Northwest and Alaskan Indians is a good example of symbol writing. In later years the more advanced tribes devised crude codes by which they sent messages by means of smoke.

FIG. 2
Boy Scouts in mountain of N. Y. State signaling from a platform erected in a tree.—*Courtesy of Boy Scouts of America*

Many hundreds of years ago the ancient tribes in Europe put into practice the habit of carving picturegraph stories on rocks. Like the American Indians, they later found methods of sending their messages through space with the aid of a cumbersome code and lighted torches.

It seems that the earliest forms of optical telegraphy, as visual signaling is sometimes called, involved the use of firebrands or torches. Of course these could only be used at night, and his-

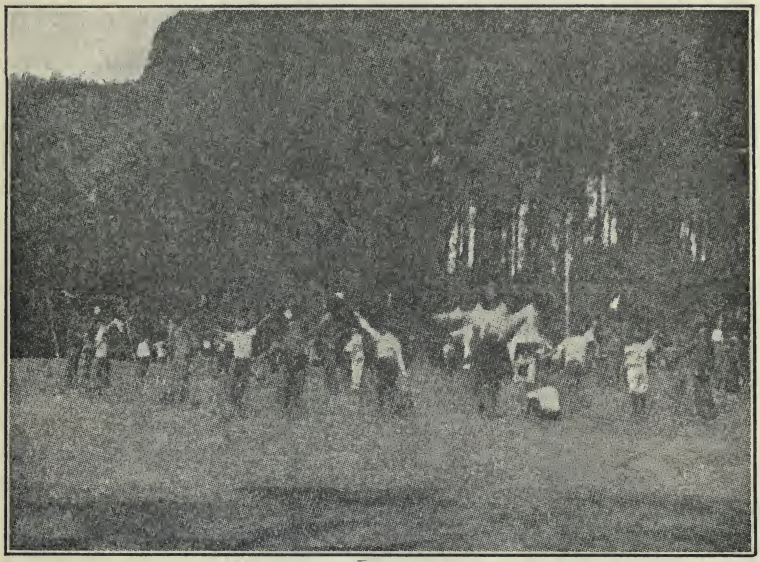


FIG. 3

Boys practicing signals at a Scout Camp.—*Courtesy of Boy Scouts of America*

FIG. 4

Boy Scouts of a Denver, Colo., Troop practicing semaphore.—*Courtesy of Boy Scouts of America*

tory gives us no reliable records of any day signals until the earlier forms of semaphore hundreds of years later.

About 200 B. C. a method of signaling was employed by the Greeks, in which torches were used. A system of measuring the flashes or exposures so as to make a simple code was invented.

The Romans also used torches for signaling, and during the early Greek and Roman Wars probably the first step was taken in Signal Corps organization. These warrior signalmen were known as "fire shakers," and to obtain points of vantage they built in many places throughout Europe signal stations, some of which are still standing to this day.

Mention is made in the Old Testament of lighting signal fires for the purpose of conveying intelligence. It seems that the method of using signal fires and torches was very popular among the early signalmen. The fact remains that even as late as the Civil War in America torches were still in use by the Signal Corps of the Blue and Gray Armies and are rivaled today only by the more modern devices in which lanterns and electric lights are used.

In the year 1623 the Marquis of Worcester (England), invented a plan of letters for signaling by day and night.

Monsieur Amontons (France 1663) recommended the holding up of large letters of the alphabet to be viewed by telescope.

Robert Hook of England was the first to really develop the modern idea of visual signaling. He used various shaped objects, suspended on a frame, to indicate letters of the alphabet.

Claude Chappe, a young French engineer, in 1790 invented a system of semaphore, and other Frenchmen followed him with the more advanced forms of indicators with semaphoric wings.

During the reign of Queen Elizabeth, the Duke of York (later James II) introduced a system of methodized signals from which later sprang the first British Naval Code.

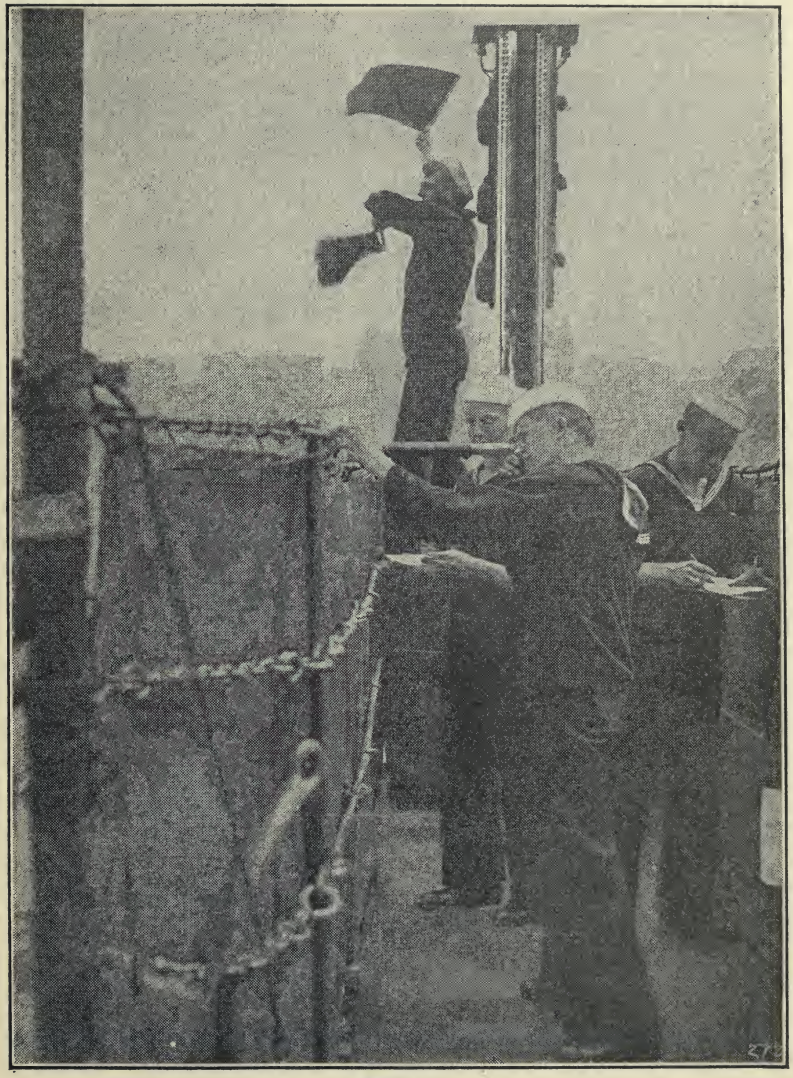


FIG. 5
Signalmen of the U. S. Navy on signal bridge of the U. S. "Wyoming"

In 1816 Sir Home Popham of the British Navy gave the world a new system of semaphore telegraph, which was adopted by the British Admiralty.

William Penn of America is also given credit for being among the first (if not the first) to get together a code and system for communication at sea.

In reviewing the history of signaling it might be of interest to know that the first telescope was invented about the year 1600. This important invention increased the range of the naked eye to a very great extent and made signaling an important method of communication.

The needs for signaling, we can see, were first wanted by armies so as to bring about rapid exchange of thoughts. It proved faster and more reliable than messengers, who were always subject to delays or liable to capture. Still, today, its paramount use is found in the armies and navies of the world, where the Signal Corps is without a doubt the most important branch.

In November, 1863, during the Civil War in America, when General Grant took command of the Union Army before Chattanooga he established his Signal Corps on a big mountain and was able to keep in touch with his forces during many of the great battles, one of which was the famous "Battle Above the Clouds," fought on Lookout Mountain. Today this mountain, from which his Signal Corps operated, is called Signal Mountain and will stand as an everlasting monument to the Signal Corps. If it is ever your good luck to visit this beautiful spot in Tennessee you will then realize to what extent accurate signals were and can be exchanged.

During the late war the Allied armies used many ingenious methods of signaling, including the improved blinker systems, sound systems and radio. One of the newest schemes is that of sending a message from the ground to aeroplanes by means of

"Panels." This is done with a code and panels of colored cloth laid on the ground.

The importance of Signal Corps work can be realized better when it is known that the Signal Corps of the U. S. Army alone, during the time it took part in the war, used 126,000 miles of wire for intelligence communications by telephone and telegraph lines. (Liaison work.)

More scientific knowledge of our neighboring planets will undoubtedly be accomplished by means of high powered signal apparatus. The matter of an exchange of messages with the inhabitants (if any) of these planets is receiving serious thought by many scientists. Several years ago a plan was advanced to do this by means of the heliograph method. This scheme was to use great mirrors with a huge shutter arrangement so as to send the messages by means of great flashes. Who can tell but what you may be able to invent the apparatus to send a message that far? It would, of course, take years to develop, but some one will eventually find a way to complete this wonder system in signaling.

Chapter II

GENERAL SERVICE CODE AND ITS USES

A code of signals is a collection of symbols agreed upon. The International Morse or Continental Code is the most widely used of all modern codes—due to its easy adaptability to so many forms of signaling.

The International Morse Code was first used for transmitting messages by ocean cables and later adopted by the armies and navies of the United States and Great Britian. By the official recognition of the Army and Navy, the Boy Scouts and other organizations it has come to be known as the "General Service Code." From this point on in the book it will be called by that term.

The General Service Code is a code of dots and dashes comprising the twenty-six letters of the alphabet and the numerals, with additional symbols.

The following signal systems are based on this code:

1. Sound system.
2. Heliograph system.
3. The Ardois system.
4. Flashing or occulting light system.
5. Very's night system.
6. The Wigwag system.
7. Radio.
8. Buzzer and Field Telegraph.

The U. S. Army, commercial telegraph lines and short cables at the present time use the American Morse which has slightly different symbols.

Alphabet—GENERAL SERVICE CODE

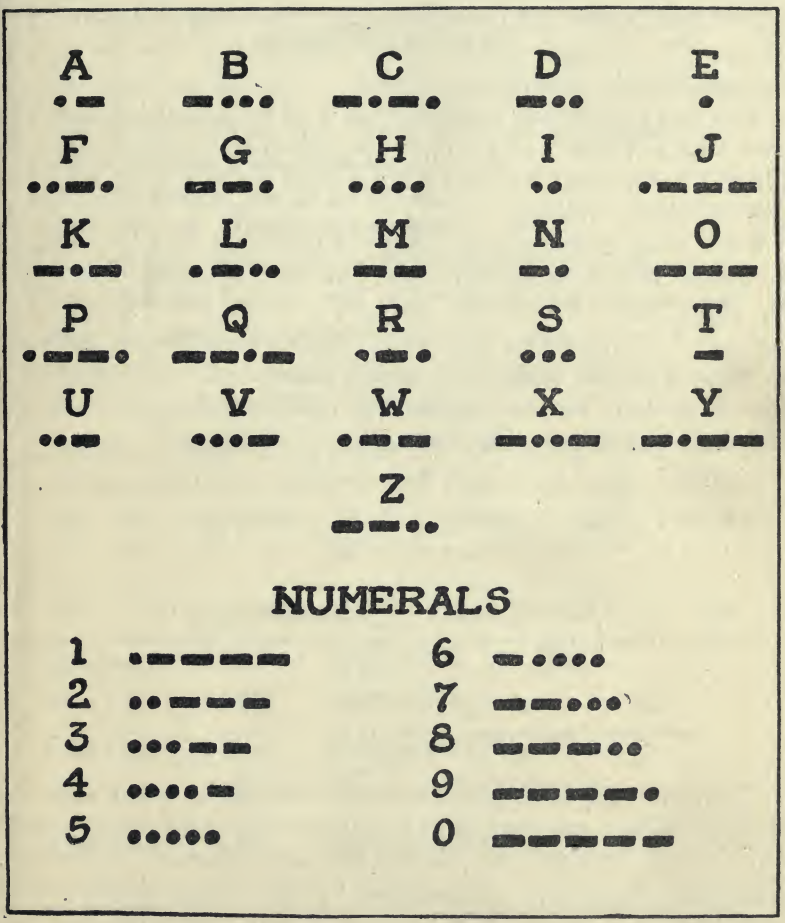
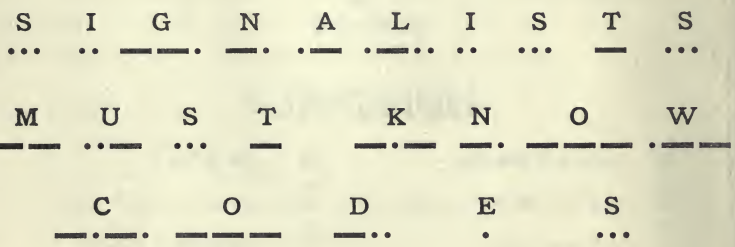


CHART 1

In using the General Service Code with some of the systems just mentioned, it is necessary at times to make some minor changes in the arrangement of sending numerals and conventional signals, but the principle of the code always remains the same. The changes will be explained from time to time as you become familiar with the systems.

You can readily see the importance of knowing this code before any advance can be made in signaling; so now turn to Chart 1 where you will find the General Service Code alphabet and numerals written.

First study the alphabet. A good plan that will help you to memorize it will be to write over and over again the characters on paper, after which you can get another boy to test your memory by having him call out at random letters of the alphabet to you. You can reply in dots and dashes. Another way is to construct short sentences and then rewrite them under the dot and dash characters. For example;



The numerals of the code are much easier to learn than the alphabet. You will note that they are written by using a combination of five dots and dashes for each number. Remember numbers are always represented by five dots, dashes, or a combination of both. Number one is made with one dot followed by four dashes, .————; number two by adding

Conventional Signals, etc., G.S.C.

PUNCTUATION

Period ·· ·· ·· Comma ·– ·–· ·–

Semicolon –·· –·· –·· Colon ––– ···

Apostrophe ·––––·

Exclamation ––··––

Hyphen or Dash –····–

Quotation Mark (beginning and ending) ·–··–·

Parentheses (before and after words) –·––·–

Bar to indicate a fraction –··–·

Underline (to be used before and after words you wish to underline) ··––·–

Double Dash (to be used between preamble and address, between address and body of message, between body and signature, and immediately before fraction)

––··––

SECONDARY MEANINGS

–·–	(K)	Negative or No
–·	(N)	Annulling
·–··	(L)	Preparatory
·–·	(R)	Acknowledgement
·––·	(P)	Affirmative or Yes

CHART 2

Abbreviations FOR USE WITH G.S.C.

T	the	DA	day	WRD	word
U	you	CK	check	MSG	message
B	be	FM	from	AHR	another
R	are	TH	through	CXK	get reply
W	with	GA	go ahead	GN	good night
TT	that	GM	good morn.	NITE	night
UR	your	OB	official business		
CN	can	OFM	official message		
BF	before	SIG	signature follows		
BN	been	ANS	answer		
HR	here	MR	move a little to right		
HV	have	ML	move a little to left		
AF	after	MU	move up	MD	move down

OK all right, is also commonly used to acknowledge receipt of a signal.

CHART 2 CONT'D.

another dot and dropping one dash, ..———— This same plan is followed until you reach number six, when you start with one dash followed by four dots —.... For number seven write two dashes and drop one of the dots, ——..., and so on down the line to zero which is expressed by five dashes ———————

Chart 2 gives the punctuation marks of the code, secondary meanings of several letters of code alphabet, conventional signals and abbreviations, most of which were taken originally from the American Morse Code but are adaptable to all methods of signaling and are used by every practical signalist.

In using abbreviations, no matter what the system, always remember they are sent as a complete word.

THE WIGWAG SYSTEM

Now that you know the General Service Code, you are ready to make use of this knowledge by practicing short messages with the Wigwag System.

In the Army, for practicing the wigwag, a stick of light wood about 18 inches long is used, and is called the wand. The wand is held loosely between the thumb and forefinger and waved rapidly to right or left to indicate letters of the code. A wand can be made easily from the small end of a bamboo pole or any light wood.

By referring to Chart 3 you will see illustrated a boy holding the single stick flag at position or ready. He is standing erect and facing squarely the receiving station which is represented on the chart. The flag is held vertically in line with center of head. This position with three motions constitutes the Wigwag System.

On the chart at the left is shown the first motion, which represents the dot. To make this motion the flag is waved from position to right of sender and back to position. This mo-

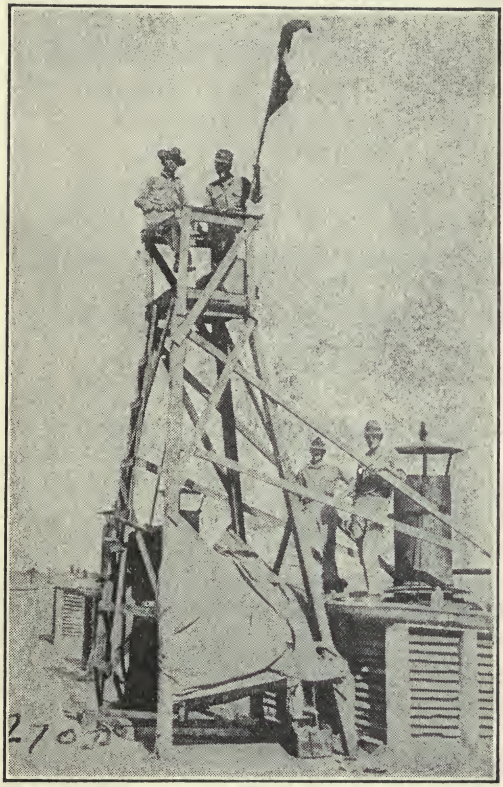


FIG. 6

Members of a U. S. Marine Signal Corps Company wigwagging from a signal tower erected on roof of a building at Vera Cruz, Mexico.—*Courtesy of U. S. Marine Corps*

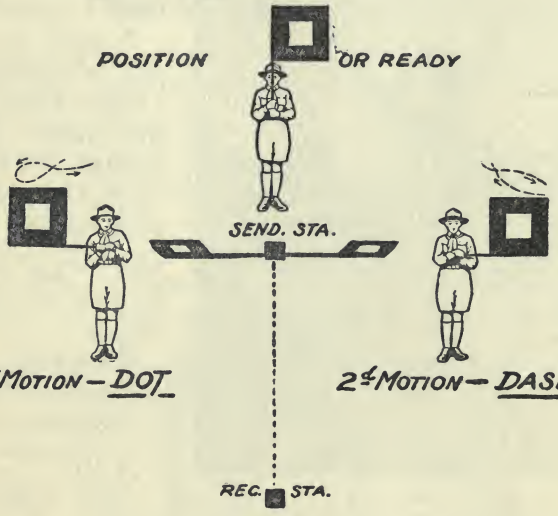
tion is always made in a plane at right angles to the line connecting the two stations as shown in center of your chart.

The second motion shown on right of chart gives you the **dash** and is made exactly as above only to **left** of sender.

The third motion shown at bottom of the chart is made by a wave of the flag from position directly in front of sender to your feet, and instantly returning to position or ready. This third motion represents front or interval. One front motion is given at end of each word, two at end of a sentence and three upon completion of a message.

In making a letter of the alphabet—say the letter **Q**—four strokes are made; i. e.—**LEFT LEFT RIGHT LEFT.** It is not necessary to pause at position in going from extreme left to right or vice versa. However, a slight pause should be allowed

Wig Wag System



ONE FRONT MOTION - END OF WORD.

TWO FRONT MOTIONS — END OF SENTENCE.

THREE FRONT MOTIONS — END OF MESSAGE.

3d MOTION OR FRONT

CHART 3

FIG. 7
Boy Scouts sending a message by two-arm semaphore.—*Courtesy of Boy Scouts of America*

at the completion of each letter. Then continue to finish your word and to give the front signal.

A great deal of practice is necessary to become a rapid sender by the single stick flag. Care should be taken not to foul the flag on the staff, as the full fly of your flag should always be seen by the receiving station. This is sometimes hard to do, especially on a windy day, but experience will teach you how it is best to avoid a troublesome situation.

The U. S. Army uses two standard outfits for wigwagging. These are known in the Signal Corps as kits. The two-foot kit contains a three-jointed hickory staff, jointed with brass screw ferrules, and when fitted together makes a strong pole 69 inches long. The flag is made fast to pole by means of three ties of tape. These are looped through brass eyes on pole.

Two flags, the size of each being 2 feet square, are provided, one of bright red material with a white center 8 inches square and the other white with red center. The flags and pole can be packed in a canvas kit about 2 feet in length.

The other outfit used is the "four-foot kit." In this outfit the

pole is heavier and when jointed is 12 feet in length. The two flags are 3 feet 9 inches square with 12-inch centers; they are of alternating colors, red and white, as in the smaller outfit.

THE FLAG, LIMITATIONS AND BACKGROUNDS

The size of the wigwag flag to be used depends entirely on the distance you want to transmit a message, and whether or not the receiving station is equipped with glasses. Under ordinary conditions a flag of 18 inches or 2 feet can be read a distance of one mile without glasses and two miles with glasses. This is the extreme limit for a flag of that size.

Nearly all single stick flags are made up of a combination of red and white colors, as these colors usually give greatest contrast. Red and orange is also a good combination.

Always select the color of your flag so as to give greatest possible contrast against the background. The white flag should never be used where your background is a snow-covered hill or light sky; but if sky is heavily clouded a white flag will prove best. The red flag should be used against a light background, of course. As some backgrounds are very de-

FIG. 8

Boy Scouts of Ansonia, Conn., sending a long distance wigwag message at sundown.—*Courtesy of Boy Scouts of America*

ceiving at times, it will take a little study on your part to determine the proper flag to use for particular conditions.

THE TORCH AND LANTERN WIGWAG

At night the signal flag is of no use; the substitute is either the torch or lantern.

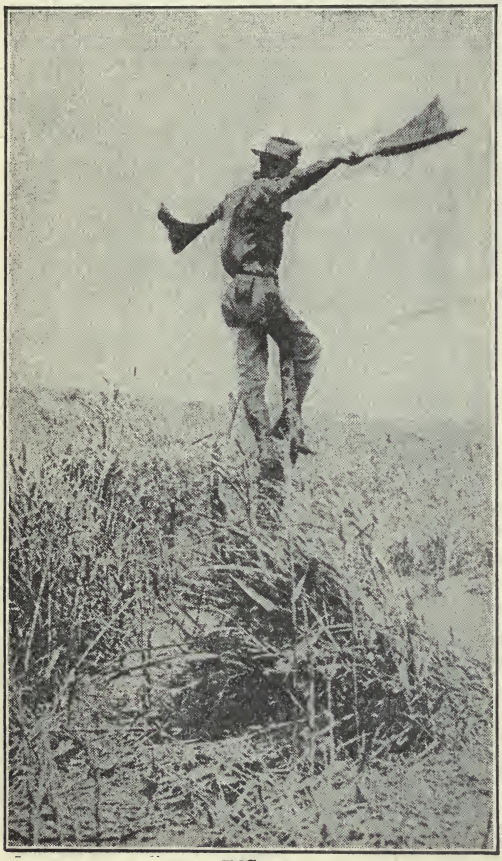


FIG. 9

A U. S. Marine semaphoring, Haiti, West Indies.—*Courtesy of U. S. Marine Corps*

If you are out in the woods and want to send a message at night to an adjoining camp and have no torch or lantern at hand it is great fun to use firebrands. Selected sticks of dry wood can be placed in the camp fire and allowed to burn a minute or two. The signalist can then send a message to his comrades. It will surprise you to learn the distance you can send messages by this method. Care should be taken to get out of range of your camp fire, as its reflection would hinder the receiving party. Signaling at night is always subject to

FIG. 10
U. S. Army Signal Corps on Mexican Border

more adverse conditions than by day. Therefore it is advisable to send messages much slower at night. Where the distance is great, an additional light should be placed in line with center of your body and about 2 feet from the ground to act as an indicator or point of reference in the motion.

About the most practical way of wigwagging at night is to use two lanterns, one for the indicator and the other for transmitting. Care should be given at night to the front motion, so as to make it distinct. This motion can be simplified somewhat by moving the lantern vertically from your head to your indicator light. For long distances you can fasten a lantern to a pole.

A good torch can be made by nailing an old tin can to a pole about 6 feet long; stuff the can with old rags or waste; pour over these a little oil and light with a match. This will give you a torch that will burn long enough to send any message of reasonable length.

WIGWAGGING BY SEARCHLIGHT

The beam of a searchlight may be used for wigwagging at night and in the U. S. Navy it is very frequently used. The rays of the light are directed vertically and swing from right to left to indicate the dots and dashes of the General Service Code. All motions are the same as in the single flag Wigwag System.

Chapter III

GENERAL INFORMATION AND ADVICE TO SIGNALISTS

Now that you have become familiar with the General Service Code and one method of sending it, a few rules can be given that will be of help in all systems of signaling. Many bits of this advice may sound military, but you may well take heed of it for it is essential to practical signaling—more so if you are a Boy Scout or some day have occasion to work with a military organization.

Signaling, like all professions, has its established terms and a correct plan of procedure. To gain a full knowledge of signaling it is necessary that you become accustomed to handling a message correctly.

A **Signal Station** consists of one or more signalmen operating as a unit and ready at all times to send or receive a message. The station can be either temporary or stationary.

The **Home Station** is station to which you are assigned.

The **Sending Station** is station sending message.

The **Receiving Station** is station receiving message.

To **Call** a station, it is the usual plan first to attract attention. This is done in the various signal systems as follows:—

1. Wigwag system: Succession of dots and dashes.
2. Semaphore system: Waving flags at attention.
3. Sound system: Succession of dots (or toots).
4. Heliograph system: Long and short flashes.
5. Ardois system: Display of four white lights.
6. Radio system: —.—.—
7. Buzzer system: Station call letter.

8. Telegraph system: Station call letter.
9. Flash light system: Short flashes or dots.

In addition to attracting attention, if the call letter or letters of the station you desire to communicate with are known, the signal representing them should be made at intervals. It is very important that each signal station has a call of one or two letters. Any letters can be adopted such as **X** or **XY**. This is essential for the reason that you may be facing and within signal distance of two or three stations at times and want to send only to one of these, individually. Note: If call letter is unknown, use the letter **A**.

The **Receiving Station** always acknowledges your call by making **R** and its call letter. After this acknowledgement you are ready to proceed with the message.

THE MESSAGE

The plan of the message varies at times, according to the organization; however, all messages are divided in a general way as follows:

1. Preamble.
2. Address to.
3. Text of message or body.
4. Address from or signature.

The preamble of the message is reserved solely for use of signalmen dealing with the message. The preamble or introduction of a message consists of the serial number of message and time message is handed in at station and accepted for transmission.

All stations use serial numbers in handling messages, beginning with number one and so on up for each twenty-four hours, after which a new series is started. Next comes the call letter of sending station or office of origin, the signalist's personal signature (all signalmen must use a personal signature as, J. J.

for John Jones, etc.) the check of message (number of words in body of message), and the class of message.

To arrive at the exact number of words in the body of a message this rule is followed: Include in count the address after **TO** and all words in body, including the address following **FROM**, but do not count **FROM** or **SIG.** if that term is used by signalists. Abbreviations, figures and names of cities and states should be counted as one word, for example: C X K (get reply) is one word; South Chicago, Illinois, or So. Chi. Ill., is counted as two words; and one-quarter as one word.

The message usually indicates whether it is official business (OB) or official message (OFM) as collect, or paid message, urgent, etc.

The Address of a message should always contain enough words or information to insure its delivery.

The Address **FROM** should convey the same amount of intelligence.

The Double dash —...— of the General Service Code is always used between the preamble and address **TO**; between the address and text; and between text and from or signature.

The following is a message handed in at a signal station at Brown's farm (call letter B) at 10 A. M. to be transmitted to station X Y (Smith's Crossing). Signalist John Jones (J. J.) takes the message:—

(To) Bill Smith,

Smith's Crossing.

Get your gang together and meet me at the Stony Creek Bridge at 2 P. M., I will bring the bunch, don't forget your skates, ice is one-quarter foot thick.

(From) Harry Brown, Brown's Farm

Get reply to this message. (C X K)

After Jones checks the message he finds it contains 38 "signal words." He numbers it 8 (as it is the eighth message he has sent that day from his station) and decides to send it by single flag wigwag. After getting attention of station X Y he proceeds to send as follows:

8 (— — — — . .) interval or front TEN front A. M. front, B (Brown's Sta. call) front, C.K. 38 (message check) front, J.J. (Jones' signature) front, OF (official message) front (— . . . —) (double dash) TO: front Bill —— Smith —— Smiths ——Crossing —— get —— ur —— gang —— together —— and —— meet —— me —— at —— t —— Stony —— Creek —— bridge —— at 2 (. . — — — —) —— P.M. —— I —— will —— bring —— t —— bunch —— don't —— forget —— ur —— skates —— ice —— is —— (— . . .—) (double dash used before fraction)—— 1 (. — — — — —) — (— . . — .) (indicating fraction bar)—— 4 (. . . . —) —— foot —— thick —— (— . . . —) (double dash) —— SIG. —— Harry —— Brown —— Browns —— Farm —— C X K (get reply) —— (. — . — .) (cross) or (. . . — . —) (meaning end of work).

Station XY acknowledges receipt of message by O.K. or . — . (R). The receiving station has a record of this message as sent above and the transaction is complete.

Of course, if you are not an expert signalman, to lessen liability of errors, it is best to spell out all numerals, fractions and abbreviations.

A message handed in at a signal station should always be looked over, for an omission of one word may change the meaning of the whole message. The advantage and importance of checking by sender and in the recheck by the receiving station can be seen at once.

Both sending and receiving stations should record on the message what system was used in handling it. The date should also show, although the serial numbers, in a measure, indicate

the dates. As you will recall, they are changed every twenty-four hours.

In military organizations all messages are considered strictly confidential.

DUTIES OF A SIGNAL UNIT

You have been told that a signal station consists of one or more signalmen operating as a unit. Where there is more than one, each must have his duties to perform; therefore, it is advisable where three boys are operating a sending station to know just what each boy's duty is.

First Boy or **Caller** takes charge of the messages, checks same and makes proper entries. When message is ready to send he calls the word or group to

Second Boy or **Sender** whose duty it is to send the message as called. His other duty is to see that his sending equipment is always in good condition.

Third Boy or **Answer Reader** reports signal as being answered and watches for interruptions from receiving station, using binoculars when necessary. Note: Should four boys be operating a station, the fourth boy will act as a messenger.

INTERRUPTION OF MESSAGES

At times signal units have a good many messages on hand to dispose of and have these messages in course of transmission when a very important urgent signal is handed in. It then becomes necessary to make the **Break Signal,** which is the attention sign by all systems. As soon as the break is acknowledged, proceed with the more important message.

The Answer Reader should always be on the lookout for

signs of error from receiving station and report to sender what portion of message has been missed.

The duties of these boys at a receiving station are similar.

First Boy, Reader (with binoculars), reads each letter, sign or numeral, calling out group on ending of each word, etc.

Second Boy, Answerman, stands by to make any necessary interruptions and to answer signal as required.

Third Boy, Writer, writes on signal form each group or signs as called out by the reader.

The first boy must be an expert on signals, for it is his duty to take charge of the signal unit. When his station is acting as a receiving station, it is his business to read correctly all messages. He should enforce a certain amount of discipline around the station, and not allow any unnecessary talking, etc., while signalmen are operating.

INTERVALS

The intervals of the General Service Code were purposely omitted in Chart 2 so as not to confuse you with their secondary meanings. They are as follows:

Interval	Double Interval	Triple Interval
.—.—	.. .. ..	.—.—.
	(same as period)	(same as cross)

Intervals are expressed as follows in the various systems:

	Interval	Double Interval	Triple Interval
1. Wigwag	front motion	(twice)	(three times)
2. Semaphore	flags crossed or machine closed	2 chop-chop signals	3 chop-chop signals

	Interval	Double Interval	Triple Interval
3. Sound			
(Bell)	... (short taps)	.. .. ..	. .. .
(Whistle)	long blast	.. .. ..	.—.—.
4. Radio, Flashing light, Heliograph, Buzzer and Telegraph	(space)	.. .. ..	.—.—.
5. Ardois	.—.—	(twice)	(three times)

CODE TIME

You have been informed that, when a message is handed in at station and accepted for transmission, a record of the time is made and sent in the preamble. This code time serves to show how long a message has taken to pass through the hands of the signalmen.

In order to save time to spell out or to send code time by numbers, the Letter Clock System is sometimes used.

Chart 4 gives you the letter clock, which is an ordinary clock-face with letters placed against the hours. The twelve hours are denoted by the first twelve letters of the alphabet, omitting the letter J. These letters stand not only for the hours but also for periods of five minutes; for example: **A** would be one o'clock and five minutes past any hour, **B** two o'clock and ten minutes past any hour, and so on. **AA** would mean one five, **AB** would mean one ten. To denote intermediate minutes the letters **RSWX** are used in every period of five minutes. Thus **MR** means one minute past twelve; **MS** means twelve two.

The hands of clock shown on your chart show time to be four minutes past six o'clock and the letters that denote that time

LETTER CLOCK

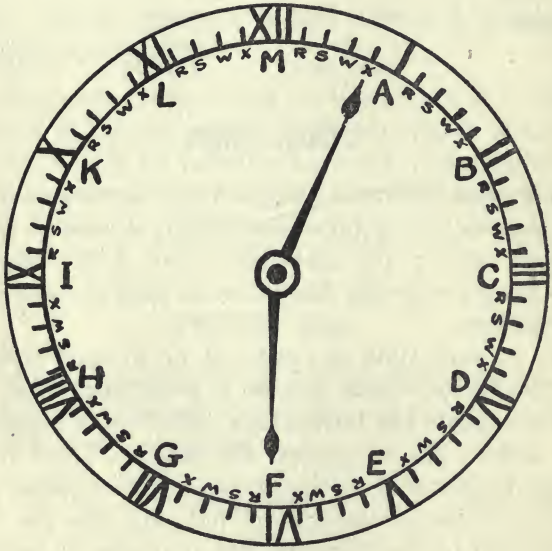


CHART 4

are **FMX,** reading in code time 6.04 either A. M. or P. M. as case may be.

Should a message be handed in at a station at exactly noon or midnight it would have to be recorded by code at one minute past to avoid confusion. The message handed in at noon would be put in code as **MR** P. M. and at midnight **MR** A. M.

Chapter IV

SEMAPHORE SYSTEM

The word semaphore is derived from the Greek word seema, meaning a sign, and phero, to bear or carry. This system is sometimes called brachial telegraph, meaning telegraphing with arms.

THE SEMAPHORE MACHINE

The two-arm semaphore machine is used in permanent stations only, as it is not a portable piece of signal apparatus.

The semaphore machine is authorized for use of the U. S. Army at fixed stations and is used on all the larger ships of the U. S. and other navies.

This semaphore machine has two arms or vanes for forming the characters of the code and a third arm or indicator displayed on right of sender (on left as viewed by receiver) as a point of reference to motion.

Semaphore machines are usually about 8 feet high, with arms of 2½ or 3 feet. The arms are operated by two levers which are placed on the machine at average height of elbows of the body. An additional lever operates the indicator arm.

The machine is painted black or gray, while arms and indicator are colored a light yellow.

For night use the machine is fitted along entire length of the arms with electric lights. The indicator is used by day only to indicate direction of sending; at night, instead of the indicator, a red electric light is used at top of machine. This light is screened to rear, and if machine is facing receiving station squarely it will

SEMAPHORE MACHINE

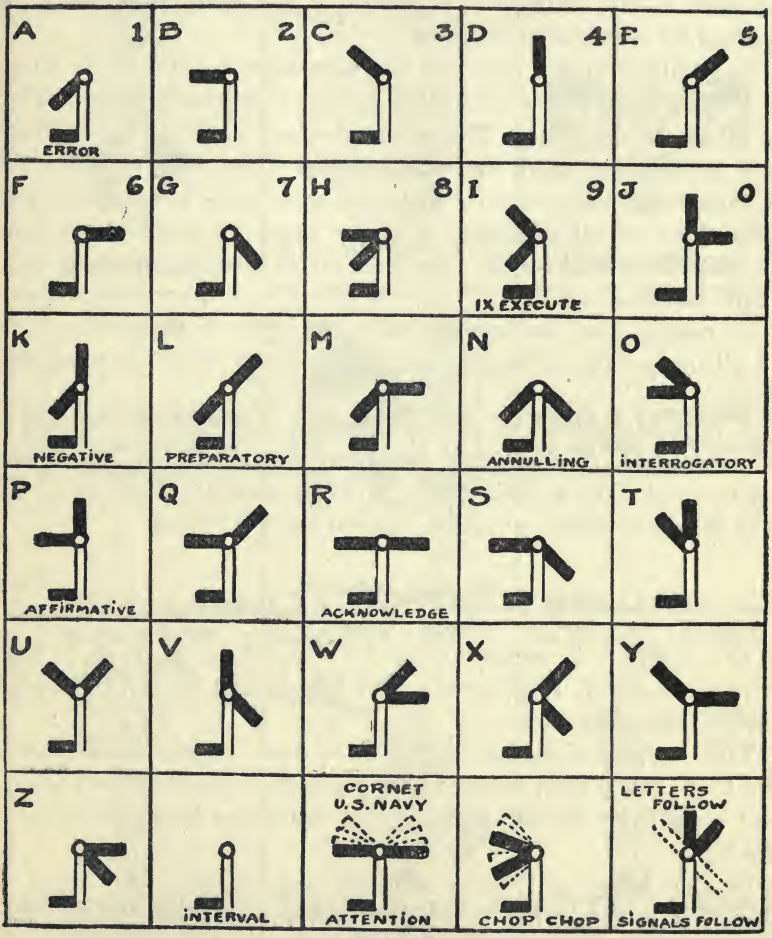


CHART 5

not be seen. Semaphore machines are mounted on a pivot so as to turn in any direction.

Chart 5 will show you alphabet of the semaphore code expressed by a two-arm machine.

In addition to the two-arm machine used by the U. S. Army and Navy there are several other types of machines, some having as many as six arms. The most common of these is the four-arm semaphore used for transmitting distant signals by the International Code and by fixed shore stations to communicate with ships of all nations. A great many of these semaphore stations are found on the coasts of Great Britain, France, Italy, Spain and Portugal.

Of course you are familiar with the type of semaphore used by all up-to-date railroads, but do you know what these signals mean?

A vertical position of arm means safe—at night a white light is displayed. A horizontal position of arm means danger—at night a red light is displayed. The intermediate position of the arm means caution—at night a green light is shown.

TWO-ARM SEMAPHORE BY HAND FLAGS

The method of semaphoring by hand flags is used in both Army and Navy, Boy Scouts, Girl Scouts and nearly all organizations using signals.

This system of signaling has been more highly developed in the U. S. Navy than in any other place on account of its rapidity and simplicity for the exchange of messages between ships of the fleet.

In the Army and other military organizations this type of signaling is somewhat limited on account of short range. The usual range for hand flags of 18-inch size is about one mile with the naked eye, and is always dependent upon your background

TWO-ARM SEMAPHORE

INTERVAL

CORNET U.S.N.

ATTENTION

DOUBLE INTERVAL IS TWO CHOP CHOP SIGNALS.

CHOP CHOP

TRIPLE INTERVAL IS THREE CHOP CHOP SIGNALS

U. S. ARMY

NUMERALS (FOL'LW)

U.S. ARMY - NAVY

SIGNALS (FL'LW)

U.S. ARMY - NAVY

LETTERS (FL'LW)

CHART 6

TWO-ARM SEMAPHORE

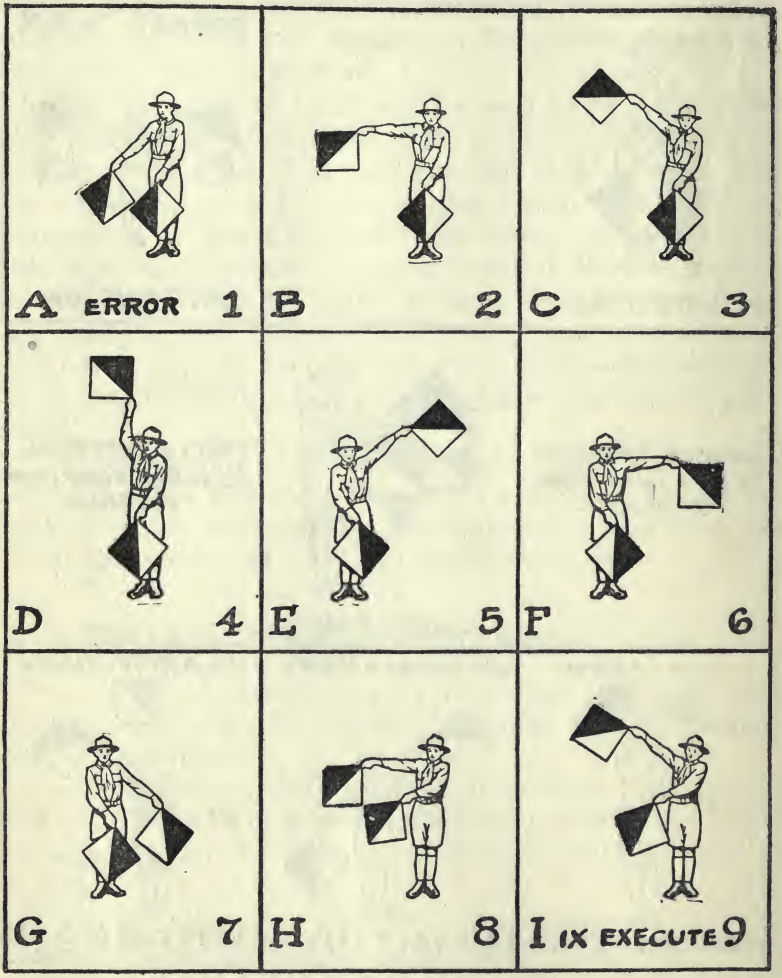


CHART 6

TWO-ARM SEMAPHORE

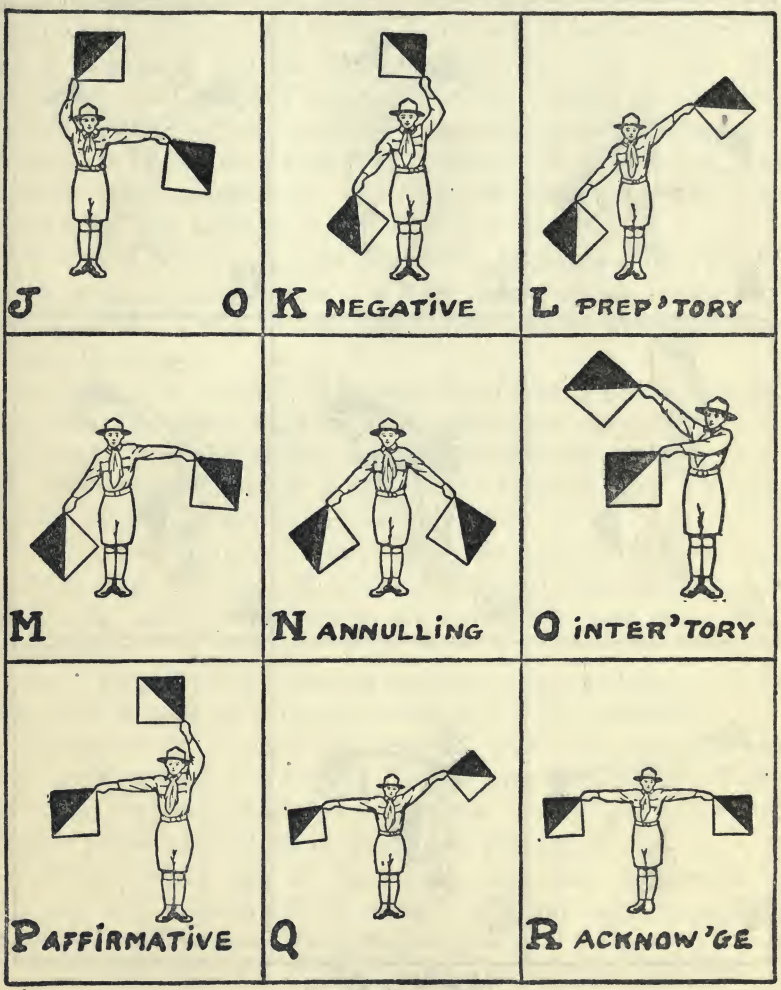


CHART 6

TWO-ARM SEMAPHORE

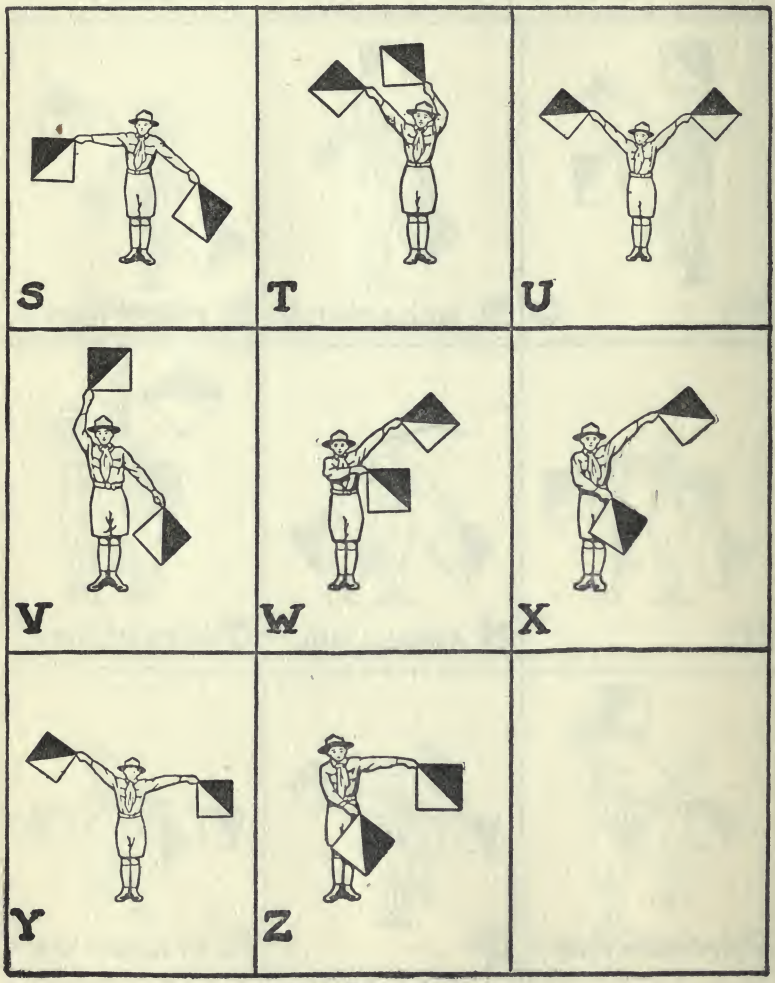


CHART 6

and the light. Much greater distance is possible, of course, with use of a telescope.

The size of flags used by the Army are 18 inches square, divided diagonally into two parts—one red, the other white. The field and coast artillery use the same size except as to colors, which are scarlet and orange. The arrangement is a 9-inch square in center of scarlet and a border of orange for work against dark background. For light backgrounds the order is reversed. The staffs used are 24 inches long.

The U. S. Navy uses flags from 12 to 15 inches square of blue with white square center for light backgrounds. For dark backgrounds, a flag of red and yellow colors, arranged diagonally is used.

Now turn to Chart 6 and study the different positions. The boy is holding the flags so as to make the characters of the alphabet. You will notice that all positions by hand flags are the same as by machine, excepting the interval, which is made by crossing flags in front of sender's legs.

The quickest way to learn semaphoring is to practice with one of your friends. After memorizing all the characters of the code, send simple words to each other and later short messages.

In making the characters all motions, pausing slightly following each, should be sharp and distinct to avoid confusion.

At the end of a word the interval shown on the chart and already described is used. At the end of a sentence the double interval, two chop-chop signals, is made. At the end of the message a triple interval, three chop-chop signals, is used.

The chop-chop signals shown on your chart are made by placing both arms vertically to right of sender and by working flags up and down in a chopping motion.

Additional symbols found in your chart are attention or cornet, numerals follow, signals follow and letters follow.

This attention signal is, of course, used to get attention, and is made by agitating the letter **R.**

The numerals follow signal is made by crossing flags over head and is used to designate the fact that you intend to use the numerals which are expressed by secondary meanings of your alphabet letters A to J as shown on chart. The numerals are made by semaphore in this way by all organizations except the Navy, where regulations require them to be spelled out in full. The interval must be used following each numeral.

Signals follow is made by reversing the letter **L** and is used to designate the fact that a code message or secondary meanings follow.

Letters follow is used only by U. S. Army and Navy and is made the reverse of the letter **T.** It signifies letters will be used to spell words.

A great many of the conventional signals and abbreviations given in your General Service Code can be adopted for semaphoring. To indicate an error in semaphore the letter **A** is used as in the General Service Code. As **A** already has a secondary meaning (the numeral one) it is necessary to agitate your flags a little.

The conventional interrogatory signal is made by agitating the letter **O.**

In sending an official message by semaphore the same rules are followed as given in preceding chapter.

No punctuation marks are given in the semaphore code and if used they must be spelled out.

Do not slur your letters in semaphoring but make them exactly as shown on charts. However, now that you are becoming a real signalman, it will not do you any harm to know that experts at semaphore signaling sometimes deviate from the regular motions. To explain this in a practical way, spell the following word without moving your right arm, after mak-

ing the first letter of word **MANILA.** Spell **BED** also with right or left arm only.

In semaphore signaling when sender makes an "end of word" sign, the receiver acknowledges this, if the message is understood, by extending his arms horizontally and by waving them until the sender does the same and message is finished.

By machine, the receiving station fixes his call letter stationary until the message is received and understood and then the machine is closed.

Chapter V

SOUND AND FLASH LIGHT SYSTEMS

SOUND SYSTEM. As early as the 17th century attempts were made to establish communications by artillery and musketry firing. The system of sound signaling came into use at this time.

The sound system is based on the General Service Code and is used more commonly by the ships of the Merchant Marine and the U. S. Navy. However, due to its aptness to cause confusion, it is rarely used by ships except in cases of emergency, such as in fogs or when a breakdown of other signal apparatus occurs and only in regions unfrequented by other vessels.

Messages are sent by the sound system by use of steam whistle, foghorn and bell.

When the steam whistle is used, messages are spelled out, except in the case of the U. S. Navy, which uses the Navy Code.

The intervals by all methods of the sound system are expressed as previously given in Chapter 2, under intervals. You will notice a difference in signals for interval in case of the whistle or bell.

In the case of the whistle one long blast represents the dash and a short one for dot; but in use of the bell a continuous sound cannot be made, therefore it is necessary to use two strokes to make a dash and one stroke for a dot.

SOUND SIGNALS BY BUGLE

The Navy has lately adopted a code for signaling by bugle or trumpet; this code was invented by a high school student of West Roxbury, Mass. The code is given you in Chart 7. No

U.S.NAVY BUGLE CODE —

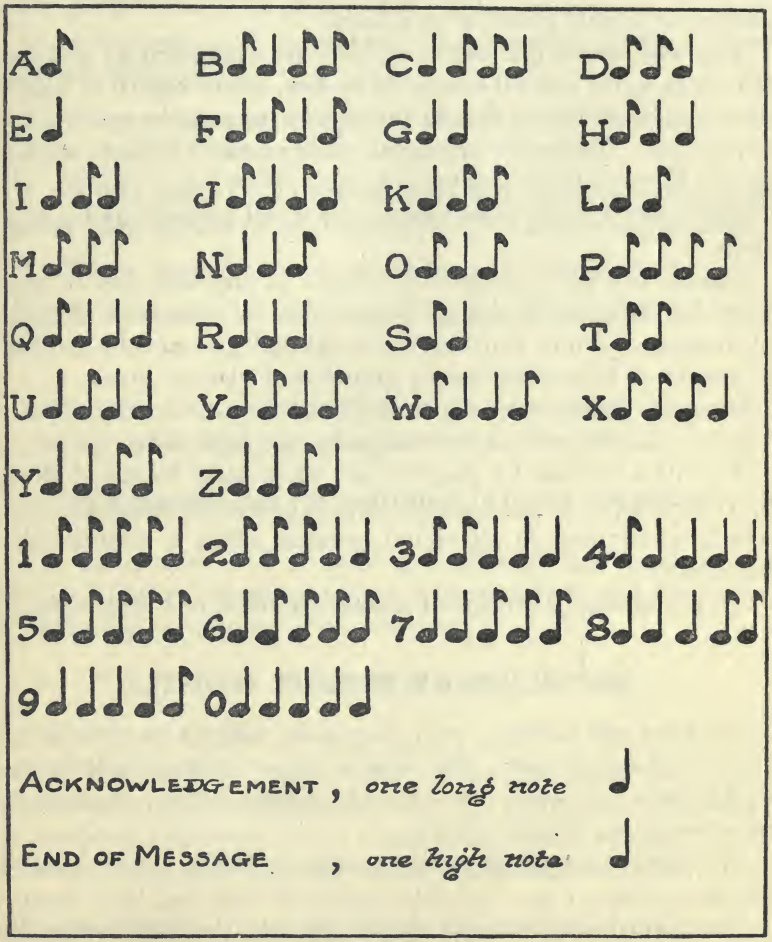


CHART 7

special musical knowledge is necessary to sound the characters of the alphabet and numerals, except to acquire what is known by players of wind instruments as the "lip," which comes very easy with a little practice on a horn.

You will notice the letters of code are expressed by not more than four notes and all numerals by five, either eighth or quarter notes. The relative value of the eighth note to the quarter note is one-half. Therefore an eighth note is made by a short blast on the horn and the quarter note by a blast twice as long. The eighth notes are the ones having the small pennant at tip of the stem.

Signals can be sent by this method in any key, but it would be very confusing to change key or pitch of your tone in middle of message. Avoid slurring the notes and give special attention to length of blast signified by eighth and quarter notes.

Intervals between words in Bugle Code are made by allowing a space, and the end of a message by one high note.

To call a station by Bugle Code blow long blasts—followed by station's call letter. If call letter is unknown, use the letter **A** which is common in all signal systems when a station call is not known.

To acknowledge receipt of a message blow one long note.

SIGNALING BY POCKET WHISTLE

All boys are familiar with the police whistle or similar type carried by Boy Scouts. The cost of these whistles runs from 15 to 50 cents and every boy should possess one for signaling or emergency use in the woods.

To signal a message by pocket whistle use the General Service Code.

The special conventional signals by whistle used by the Boy Scouts are as follows:

1. One long blast means "Silence," "Attention," "Look out for my next signal," also used in approaching a station.

2. Two short blasts mean "All right."

3. A succession of short, sharp blasts means "Rally," "Come together," "Close in."

4. A succession of long, slow blasts means "Go out," "Get farther away" or "Advance," "Extend," "Scatter."

5. Three short blasts followed by one long one from scout master calls up the patrol leaders—i. e., "Leaders come here."

6. Three long blasts means "Danger," "Look out."

7. A succession of alternating long and sharp blasts means "Mess Call."

All whistle signals should be obeyed as quickly as possible, no matter what work you may be doing at the time.

FLASHING OR OCCULTING LIGHT SYSTEM

The equipment used to send messages by this system is the electric blinker, operating with a telegraph key, and the lantern or searchlight equipped with shutters.

THE BLINKER

The electric blinker is authorized for use in the U. S. Navy and is also used by many other navies and merchant vessels. The electric lamp is usually placed at the peak of the foremast or on yardarm and operated by a key from bridge of ship. Incandescent lamps, 110 volts, are used. These are used as a night system only and, like the other systems, has its disadvantages, especially in foggy weather when used in a locality where a group of ships are at anchor displaying their many lights.

For sending messages by blinker the General Service Code is used.

THE ACETYLENE LANTERN

The standard night signal equipment used by the Army is the acetylene lantern.

Acetylene is a pure hydrocarbon gas, and is produced in the signal lantern by bringing water into contact with calcium carbide. The illumination resulting is about 1900 candle power and, with the exception of the searchlight, the acetylene lantern furnishes the most powerful form of night signaling. The range obtainable by this type of lantern is as much as ten miles with naked eye, and with a 30-power telescope the flashes can be read for thirty miles.

On dark and cloudy days this lantern can be used for day signaling at a distance of one-half to three-quarters of a mile.

SEARCHLIGHT SIGNALING

The most powerful night system used is the searchlight, which is equipped with a shutter and operated by a key. This method of signaling is used by coast artillery corps and most commonly by the Navy. While it is essentially a night system, it is also used in day sending, and ships at sea in ordinary weather have been able to send messages for distances up to ten miles.

THE HELIOGRAPH

The heliograph is an instrument designed for the purpose of transmitting signals by means of the sun's rays.

The sun being the most powerful light in existence, heliograph flashes can be sent farther than by any other method of visual signaling. When the day is clear and the sun's rays intense,

heliograph signals can be read up to forty or fifty miles, and even greater distances are on record. However, the normal range is around twenty-five miles, and to obtain longer distances it is usually necessary to operate from a large hill or mountain peak.

The principal disadvantage to heliographing lies in its dependence upon the sunlight. The advantages are portability of equipment; great range signals can be exchanged; the rapidity of sending; and most important of all is the fact that your signals cannot be observed by others unless they happen to be on the line of flash between the sending and receiving station.

Heliograph instruments vary in design according to the organization using them, but all are alike in principle. The chief parts of the equipment for a station consist of one sun mirror, one station mirror, a shutter arrangement of some sort for intercepting the flashes and a device for directing or sighting flashes on receiving station.

The Heliograph and Theory. Every boy has at some time taken a small pocket mirror or bright piece of metal from which he has reflected the sun's rays on a shadowed wall. The result on the wall is a bright sun spot or flash which can be moved at will by slightly shifting the mirror. As this flash is the important factor in heliographing, it must be produced and directed at the receiving station with a great deal of skill.

The mirrors used in heliographs are usually not over 4 or 5 inches square. Two mirrors are made necessary by the position of the sun at time one is sending. When the sun is at right angles to the line joining the two stations, only one mirror is used—the sun mirror. With sun at rear of operator, the two mirrors are required.

With one mirror the flash is reflected directly from it to receiving station and with two mirrors the flash is reflected from

the sun mirror to the station mirror and thence to the receiving station. (See Figure 11, A and B.)

How Heliograph Operates With One Mirror. The sun mirror has in center a small peep hole or unsilvered spot about one-quarter inch in diameter. The sighting device is about 6 or 8 inches to front of the mirror. An upright rod is generally employed which can be moved up and down; the rod sets parallel with edge of mirror and has a round disc on an arm which when turned at right angles to rod falls in line with center of mirror.

To direct the flash accurately on distant stations, the operator sights through the peep hole in rear of mirror and adjusts disc so that the peep hole, disc and distant station are on an exact line. Then the sun mirror is adjusted on its horizontal axis only, so that the "shadow spot" cast by peep hole falls exactly on sighting disc. (The shadow spot can be found by placing a piece of paper between mirror and sighting device.) After "shadow spot" is located on disc the flash is visible at receiving station. (See Figure 12.)

How Heliograph Operates With Two Mirrors. The sun mirror is faced towards the sun and the station mirror towards

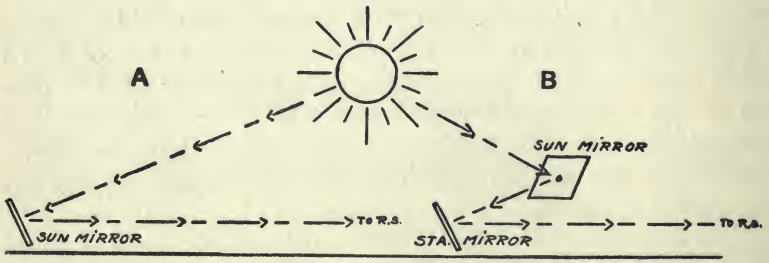


FIG. 11

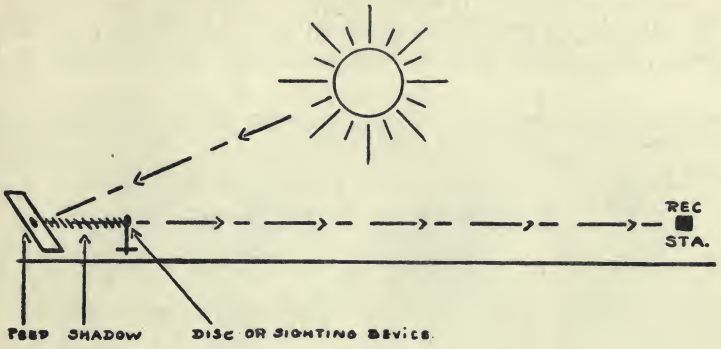


FIG. 12

receiving station. The station mirror has a paper disc pasted on its face at the center. The sun mirror is adjusted so that the whole of the station mirror is reflected into it and the unsilvered spot and reflection of paper disc accurately cover each other.

To sight flash on receiving station the reflection of the distant station will be seen in station mirror and, by adjusting this so the disc covers the reflection of distant station, the flash will then be accurately in line.

Intercepting the Flashes. The method of intercepting flashes in heliograph is either with the improved shutter with leaves operated by a key or with a single shutter held in the hand. In either case uniformity of movement should be maintained. Because of the distances it is always advisable to count slowly three times for a dot and six times for a dash.

Backgrounds. Dark backgrounds should be selected when possible for heliographing, as signals can be more readily distinguished.

To locate a distant station when its position is unknown, take

the station mirror and direct it towards the horizon, playing it in slowly from right to left several times. If no response is

FIG. 13

U. S. Marines sending a heliograph message.—*Courtesy of U. S. Marine Corps*

received, direct it at a point near the home station, and repeat this same process. As a result of this method you will usually locate the station.

If position of each station is known to the other, the station ready first will direct its flash upon the distant station so that that station may be able to adjust its flash to answer the signals.

In heliographing, the sun's movement has to be watched carefully and adjustments made often. In the case of well trained signalmen these adjustments can be made without "breaking" a message. The heliograph is best operated by two men.

Heliograph flashes are sometimes very hard on the eyes; therefore it is always a good plan to smoke the lenses of the telescope a little when its use is necessary.

THE ARDOIS SYSTEM

The Ardois System for night signaling consists of a display of red and white incandescent lamps which indicate the characters of the General Service Code. The lamps are arranged in four units, each unit consisting of a red and white lamp. The units are placed an equal distance apart and usually suspended in a vertical position from a mast, yardarm or staff, in which case characters are read from top downward. When it is necessary to place lamps horizontally they are read by sender from right to left, and in case of receiver from left to right.

A **red** lamp indicates a **dot** and a **white** lamp a **dash.** The lamps are operated by a keyboard.

The letters of General Service Code are made by a single display; for example, **A** which is .— would be made in the Ardois System by a display of the red light of the top unit and the white light of the next unit below. The letter **B** which is —... would be expressed by a white light from the top unit and the next three units below would be red.

Chart 8 gives alphabet for the Ardois System, also conventional signals and numerals.

The numerals of General Service Code cannot be used in the

Ardois Alphabet

NOTE: TO INDICATE ALL SECONDARY MEANINGS TO LETTERS OF THE ALPHABET PULSATE UPPER LIGHT — EXCEPTION, R TO SIGNIFY "ACKNOWLEDGE" IS FLASHED.

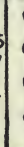
A ERROR		B		C REPEAT		D		E	
F		G		H		I		J	
K NEGATIVE		L PREPARA- TORY.		M		N ANNUL- LING.		O INTERROG- ATORY.	
P		Q_1		R_2 ACKNOW- LEDGE		S_3		T_4	
U_5		V_6		W_7		X_8		Y_9	
Z_0		INTERVAL FLASHED		CORNET STEADY DISPLAY		LETTERS FOLLOW STEADY DISPLAY		SIGNALS FOLLOW STEADY DISPLAY	

CHART 8

Ardois system as the expression is limited to four lamps. Therefore, numerals are made by giving secondary meanings to letters of the alphabet as shown on the chart.

To make a numeral, display the letter by which it is indicated, and blink or pulsate the upper light.

In the case of letters which indicate conventional signals the upper light is pulsated. The letter **R** is an exception to this. When pulsated it signifies Number 2, when flashed it is the conventional signal for "acknowledge."

The interval is made once to indicate end of word, twice for end of sentence and three times for end of message. When interval is displayed and upper lamp pulsated it is a "Designator" signal.

The general call to attention is a steady display of cornet **WWWW.** The cornet is not used, however, if call letter of station desired is known. In answer to a call, display call letter of station, the calling station then proceeds with message.

To indicate that an error has been made in the message make "interval," the "error," then "interval" and then begin with word in which error occurred.

The letter **R** flashed acknowledges the receipt of a message.

When the Ardois System is in use, it is advisable to extinguish all nearby lights which are liable to cause confusion in signals.

The Ardois System is authorized for use by both Army and Navy.

THE VERY SYSTEM

The Very System of night signaling is used by Army and Navy, its use is mainly confined to signals of extreme importance or when distance is great.

The signals are made by firing red and green stars in the air by means of a pistol which has a barrel similar in gauge to

the shotgun. The cartridges firing the stars are like the shells of a shotgun.

This system is based on the dot and dash code, a red star representing a dot and a green star a dash. This system, however, is practical only for use with Army and Navy codes and therefore is not of any service to a boy.

Chapter VI

TELEGRAPHY, RADIO-TELEGRAPHY AND TELEPHONY

All of these non-visual forms of signaling are used by the signal corps of every modern army. They are also the common means of communication in everyday commercial life.

In all of the above methods of signaling the use of electrical currents are necessary along with special instruments for receiving and transmitting messages. The theory of electric currents is a study in itself. This subject is covered in the Gilbert Electrical Manual, and any boy wishing to acquire a knowledge of electricity and to apply the theory to his apparatus can do so by consulting Gilbert Manual of Telegraphy or the Gilbert Book on Radio Engineering. The writer will confine himself to the operative side of signaling, which includes the code and proper form of handling messages over these systems.

TELEGRAPHY

An American, Samuel F. Morse, invented the first working telegraph instrument in year of 1835. This instrument was the recording or writing type, that is, it made marks on strips of paper of dots and dashes which could be spelled into a message. The recording instruments are now obsolete and all telegraphy is conducted by sounding instruments, which spell out messages by means of sharp "clicks."

THE AMERICAN MORSE CODE

The American Morse Code is used on all land telegraph lines and short cables. It is also the official code of the Army for

AMERICAN MORSE CODE.

ALPHABET

A ·—	B —···	C —·—·	D —··
E ·	F ··—·	G ——·	H ····
I ··	J ·———	K —·—	L ·—··
M ——	N —·	O ———	P ·——·
Q ——·—	R ·—·	S ···	T —
U ··—	V ···—	W ·——	X —··—
Y —·——	Z ——··	& ·—···	

NUMERALS

1 ·————	2 ··———	3 ···——	4 ····—
5 ·····	6 —····	7 ——···	8 ———··
	9 ————·	0 —————	

PUNCTUATION—

PERIOD ·—·—·— COMMA ——··—— INTERROGATION ··——··

HYPHEN (HX) DASH (DX) SEMICOLON (SI)

DOLLAR MARK(SX) FRACTION (/) DECIMAL POINT *spell "dot"*

SHILLING MARK (CUT) POUNDS, STERLING (PX)

CONVENTIONAL SIGNALS

Attention all operators	(9)	—··—
Please start me (or) where shall I start		···— (4)
Wait a minute	(min)	——·—·
I understand	(OK)	·· —·—
Busy on other wires	(2S)	··——·· ———
Test, side away	(wire)	·—— ·· —·—·
Go ahead	(GA)	——·—·
Error	(DN)	—·· —· —
Signature follows	(SIG)	··· ·· ——·
Break	(BK)	—··· —·—

NOTE :— Abbreviations same as on chart 2

CHART 9

electrical signaling on military telegraph lines, short cables and field lines. This code is written on Chart 9. Every signalist should familiarize himself with this code and learn how it differs from the General Service Code.

The beginner should thoroughly commit to memory the signs representing the letters of the alphabet, the numerals and a few of the principal punctuation marks. The remaining characters can be learned afterwards as they are not needed by a beginner.

The Morse Code is composed of seven elements:

(1) The dot; (2) the dash; (3) the long dash; (4) the space; (5) the space between letters; (6) the space between words and (7) the space between sentences.

The dot is made by pressing the telegraph key down for the smallest fraction of a second and then immediately releasing it. The result on the sounding instrument is a "click-click" very close together. The making of a dot involves time, therefore the dash is equal to two dots and to make this the key is held down accordingly. A "click——click" sound results. The long dash is equal to four dots, thus: "click————click."

The ordinary space between elements of letters is equal in time to a dot, between the letters themselves it is equal to two dots. The word space is equal to three dots and the sentence space is equal to six dots.

Correct Way of Using the Key. The most successful manner of operating the telegraph key is to let the forearm rest easily upon the table, grasping the key as shown in Figure 14. The wrist should be well above the table, the forefinger curved, but not held rigid. Let the thumb rest on the edge of knob so that a slight control of the upward motion is obtained. The raising spring should assist the upward motion but should never be permitted to control it. Avoid tapping upon the key. The

skilled operator will manipulate it by a muscular action of wrist and fingers.

Elementary Practice of Code. Constant practice of making dots with uniformity and precision must first be acquired, then dashes, then grouping of dots and dashes to form letters and words.

The beginner should commence by making letters slowly, giving proper ratio of time to the elements of each letter. Speed will come in time by persistent drill.

The most difficult letters of the code are **C O R Z Y** and **S**, termed the space letters; and if spacing in these letters is not carefully timed they will be readily confused with such letters as **H I P** and **L.**

The letters **J** and **K,** also numerals **9** and **7,** are difficult letters, Care should be given not to separate **J** into a space which would result in a double **N.**

The usual tendency is to make an **F** too long and an **L** too short.

Practice transmitting from any miscellaneous manuscript at hand. This will always test the skill of an operator.

RECEIVING TELEGRAPHY

Receiving is of course more difficult to acquire than sending and is mastered best by having an experienced operator send

CORRECT MANNER OF HOLDING KEY

FIG. 14

to the beginner slowly, increasing the speed as learner becomes more proficient.

Proper Form of Transmission. A telegraph message like all visual messages must be checked by the sender. All words and figures written in the address, body of message and the signature are counted. Of course **To** and **Sig.** are not counted as they are only indicative terms used by operator.

In counting the check of a telegraph message, whether in plain English or code, groups or initial letters are counted as one word.

Abbreviations for names of places, cities, towns and states are counted as one word, as if written in full. This rule applies also to any other abbreviations.

Figures, decimal points, bar of division and affixes to numbers, such as d, st, nd, th and rd will each be counted as a word.

RADIO-TELEGRAPHY

Radio-telegraphy or wireless, by which term it is more commonly known, was invented by Marconi in 1901. Since that time there has been developed many improvements, which make the transmission of messages by wireless almost as practical as by telegraph lines or cables.

Wireless messages are spelled out by use of the International Morse or General Service Code (see Chart 1), the operator using a key like that used in telegraphing. The result is somewhat different from telegraphing, as wireless instruments have a humming or buzzing sound instead of a "click." The characters of the alphabet are made up of short and long buzzes. The receiving is done through phones.

While wireless is under the control of the Navy in the United States the government does not have exclusive use of it. A great many commercial stations have been established and in

FIG. 15

Boy Scouts of Hartford, Conn., learning the theory of wireless.—*Courtesy of Boy Scouts of America*

this country alone there are thousands of boy experts using wireless, and enthusiasts are being added to the list daily. Note: For conventional signals other than in General Service Code see Gilbert Book on Radio Engineering.

TELEPHONY

The most widely used of all electrical signal systems is the telephone, invented by Alexander G. Bell, an American. The telephone is so common in our everyday life that most of us do not stop to consider the interesting principles involved.

Color Charts

INDEX

FLAGS OF THE INTERNATIONAL CODE

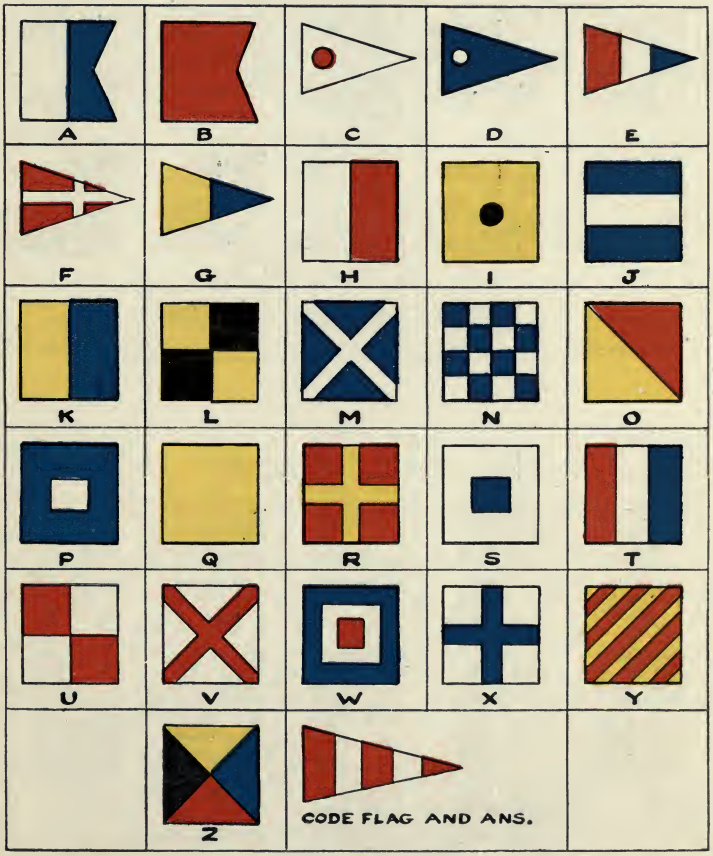
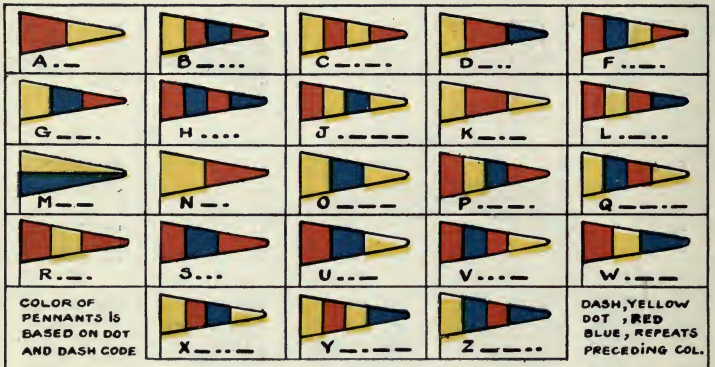


CHART 10

SHIP CALL PENNANTS



CALL FLAGS

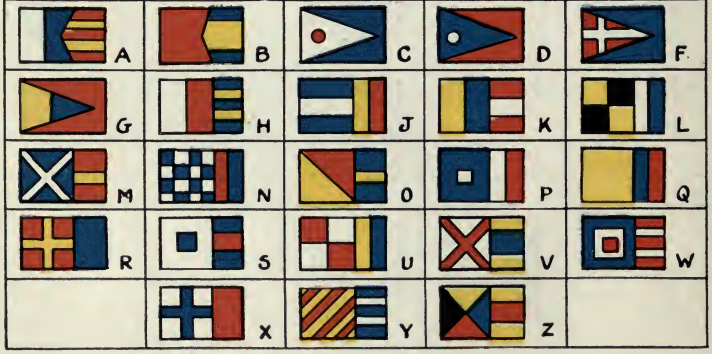


CHART 11

SPECIAL FLAGS OF THE U.S. NAVY

 CORNET	 NUMERALS	 GENERAL RECALL BOAT RECALL WITH NUM. ABOVE	 GUARD OR GUIDE	 DANGER AND DESIGNATING NAVY REG. USE
 NEGATIVE	 PREPARATORY	 AFFIRMATIVE	 ANNULLING	 INTERROGATORY
 DISPATCH BREAK DOWN MAN OVERBOARD	 1ST. REPEATER	 2D. REPEATER	 3RD. REPEATER	 QUARANTINE
 TORPEDO FLOTILLA	 SUBMARINE FLOTILLA	 SQUADRON	 DIVISION	 SUBMARINE WARNING
 CONVOY POSITION DIVISION GUIDE	 MEAL FULL SPEED FLAG OFF, LEVG.	 RED CROSS	 CHURCH	 BATTLE EFFICIENCY
 POWDER FLAG	 ANSWERING AND DIVISIONAL PT.			

CHART 12


U.S. MAN O'WAR AND MERCHANT ENSIGN
UNION JACK
PRESIDENT'S FLAG
CONSULAR FLAG
SECY. OF THE NAVY
ASST. SECY. OF THE NAVY
ADMIRAL
VICE ADMIRAL
REAR ADMIRAL SENIOR IN RANK
REAR ADMIRAL JUNIOR IN RANK
SENIOR OFFICER PRESENT
COMMISSION PENNANT
NAVAL MILITIA
NAVAL MILITIA COMMODORE
NAVAL MILITIA COMMISSION PT.
TORPEDO FLOTILLA COMMANDER
SUBMARINE FLO. COMMANDER
TORPEDO DIV. COMDR.
4
1
SUB. DIVISION COMMANDER
U.S. YACHT ENSIGN
CLUB PENNANT
COMMODORE
VICE COMMODORE
REAR COMMODORE
GUEST FLAG
OWNER'S PRIVATE SIGNAL
OWNER'S DINNER FLAG
OWNER'S ABSENT

CHART 13

WEATHER SIGNAL FLAGS

RAIN OR SNOW

TEMPERATURE FLAG

CLEAR OR FAIR

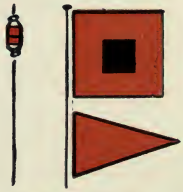
LOCAL RAINS

COLD WAVES

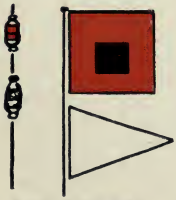
STORM SIGNAL FLAGS AND NIGHT LANTERNS

SMALL CRAFT

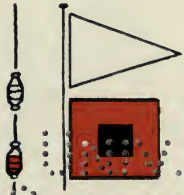
N.E. STORM



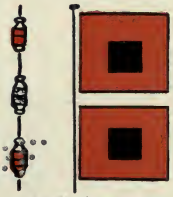
S.E. STORM



S.W. STORM



N.W. STORM



HURRICANE

CHART 14

In speaking, the vocal cords cause air vibrations, which, falling upon the eardrum are recognized by the auditory nerves as speech. When these vibrations are transmitted into a telephone instrument, they are caught by the sensitive diaphragm, changed into electrical vibrations, carried along the telephone wire to the receiving station and reproduced.

Note: See Gilbert "Sound Experiments" and Manual on Telephone.

THE TELEPHONE FOR SIGNAL PURPOSES

When signal stations are connected by telephone, messages are of course sent by this means, it being much more handy.

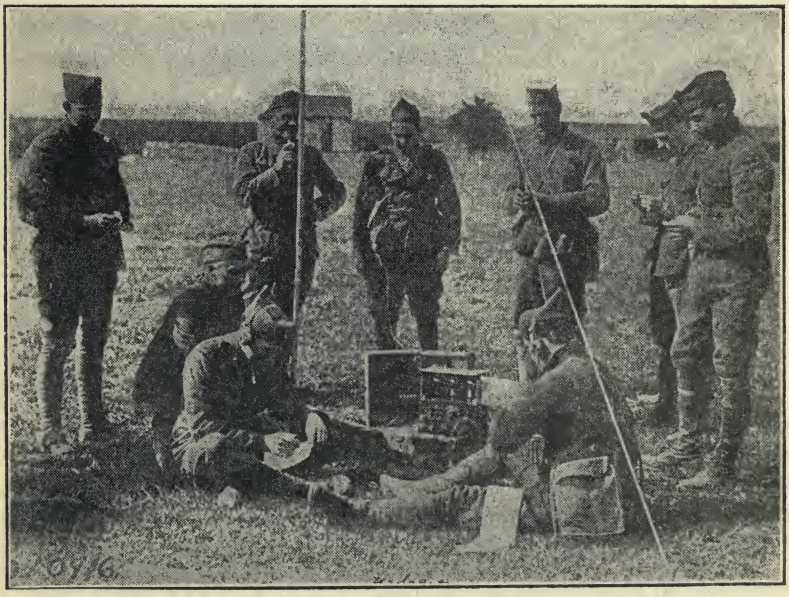


FIG. 16

U. S. Army Signal Corps field radio station somewhere in France.

The difficulty arising in telephonic messages is the confusion of certain letters of the alphabet having like sounds when spoken by word of mouth.

To provide a ready means of distinguishing similar sounding letters, a code of conventional signals is authorized for military purposes and should be used especially when codes are being sent. These conventional signals are as follows:—

A—Able	N—Nan
B—Boy	O—Oboe
C—Cast	P—Pup
D—Dog	Q—Quack
E—Easy	R—Rush
F—Fox	S—Sail
G—George	T—Tare
H—Have	U—Unit
I—Item	V—Vice
J—Jig	W—Watch
K—King	X—X-ray
L—Love	Y—Yoke
M—Mike	Z—Zed

To give an example of the proper use of this code we will suppose an important message is being telephoned to a station and the receiving operator cannot clearly understand certain words such as directory, or the word translation. To make these words clear the operator would spell directory out slowly Dog-Item-Rush-Easy-Cast-Tare-Oboe-Rush-Yoke. The word translation would be spelled out likewise. From this code a clear understanding would undoubtedly result.

THE SERVICE BUZZER

The Service Buzzer is a portable piece of signal equipment especially adapted to the needs of the Army Signal Corps. It can be readily attached to either telephone or telegraph lines and used as a telephone or for sending Morse or General Service Code telegraphic signals.

When service buzzer is used in the latter form the signals are received in a telephone receiver in form of a high-pitched hum very similar to wireless signals.

Signals have been exchanged between two buzzer outfits even after wire connecting the stations has been cut in. The instruments were, of course, grounded.

The mechanism of the buzzer is very simple, so simple in fact that any boy can make a practical outfit for Field Service Signaling by following the suggestions given in this book on page 102.

Chapter VII

THE SIGNAL TOWER

The Tower of Babel served as a rallying point and in all probabilities was the first signal station. Later examples of old signal towers are those built by the Chinese along the wall of China. Today, however, the modern signalmen do not build such substantial towers, as the up-to-date armies are mobile and consequently when a signal tower is required a portable one or a hand-made affair, which can be erected in a few minutes by field signal troops, is used.

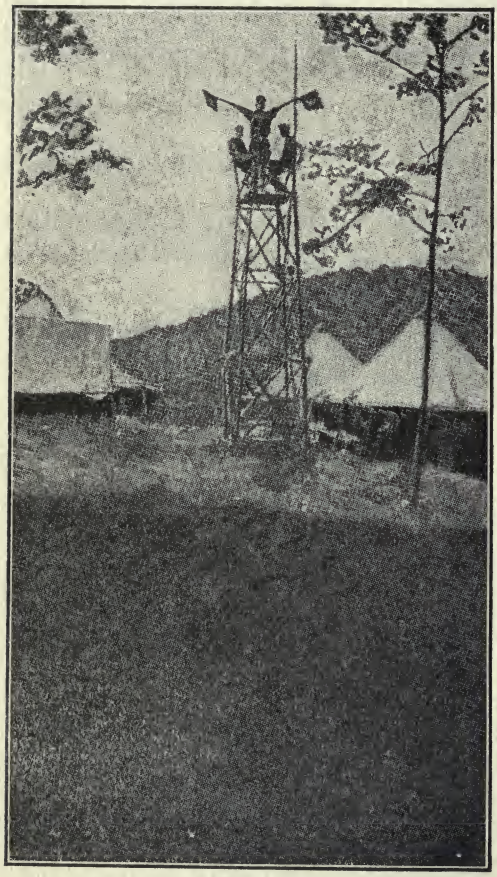


FIG. 17

Signal tower erected at a boy Scout Camp.—*Courtesy of Boy Scouts of America*

The boy signalist wanting to establish a visual station must first select the site so it is perfectly in view of receiving station and with a uniform background for all signals. The distant

station is the best judge of the proper location and background for the signal tower.

In locating a military station secrecy is of vital importance, and for this reason the tower is usually camouflaged by shrubbery or erected behind foliage so the platform of tower is barely exposed.

The following table gives distances of the visible horizon or how far an object at sea level can be seen. When observer's eye is:

5	feet	above,	the	distance	is	2.7	miles
10	"	"	"	"	"	3.8	"
15	"	"	"	"	"	4.7	"
20	"	"	"	"	"	5.4	"
25	"	"	"	"	"	6.1	".
30	"	"	"	"	"	6.7	"
35	"	"	"	"	"	7.2	"
40	"	"	"	"	"	8	"
50	"	"	"	"	"	9	"
100	"	"	"	"	"	12.2	"
150	"	"	"	"	"	15	"
200	"	"	"	"	"	17.3	"

It can readily be seen from the above table that an observer whose eye is 25 feet above sea level can distinguish an object at a distance of 6.1 miles provided the object is at sea level. Now should the object itself be elevated 15 feet its visibility would be increased to 6.1 miles and 4.7 miles, equaling 10.8 miles.

To receive visual signals at the distances given above, a telescope is used.

SUGGESTIONS FOR ERECTING A SIGNAL TOWER

The height necessary for building a signal tower should be calculated according to distance between points of communica-

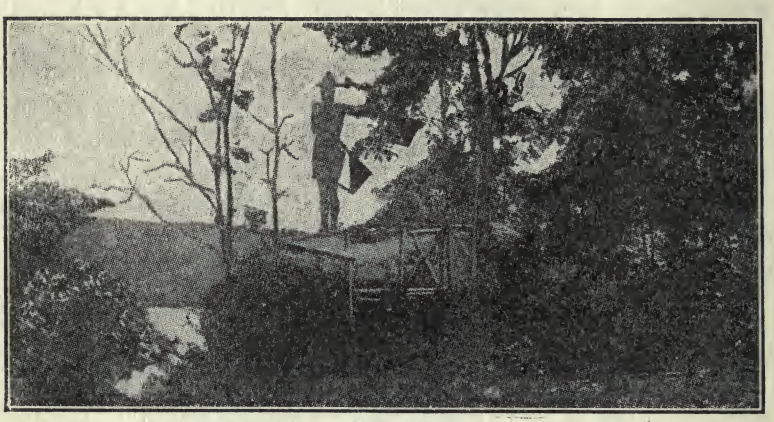


FIG. 18

A natural point of vantage for signaling.—*Courtesy of Boy Scouts of America*

tion. When possible, natural points of vantage should be used, such as the roof of a building or a platform built in a tree. Sometimes several trees can be found close together which can be connected by stringers and a platform laid around, to which a rail can be added. A ladder would lead up to the staging to complete the arrangement.

Where no natural supports can be found, it will be necessary to build a tower. A substantial tower can be erected by using either three or four uprights for supporting the platform. The uprights can be made of finished lumber, using 2x4 pieces or heavier ones, depending on height of tower wanted.

The drawing on page 71 suggests a tower made of three selected trees cut to lengths of 18 feet. These are placed in the ground about 1½ or 2 feet, the arrangement of placing being triangular and 8 feet apart. The uprights are leaned in at the top and tied 4 feet apart, on which a platform is laid which will accommodate two signalmen. The platform can be made of

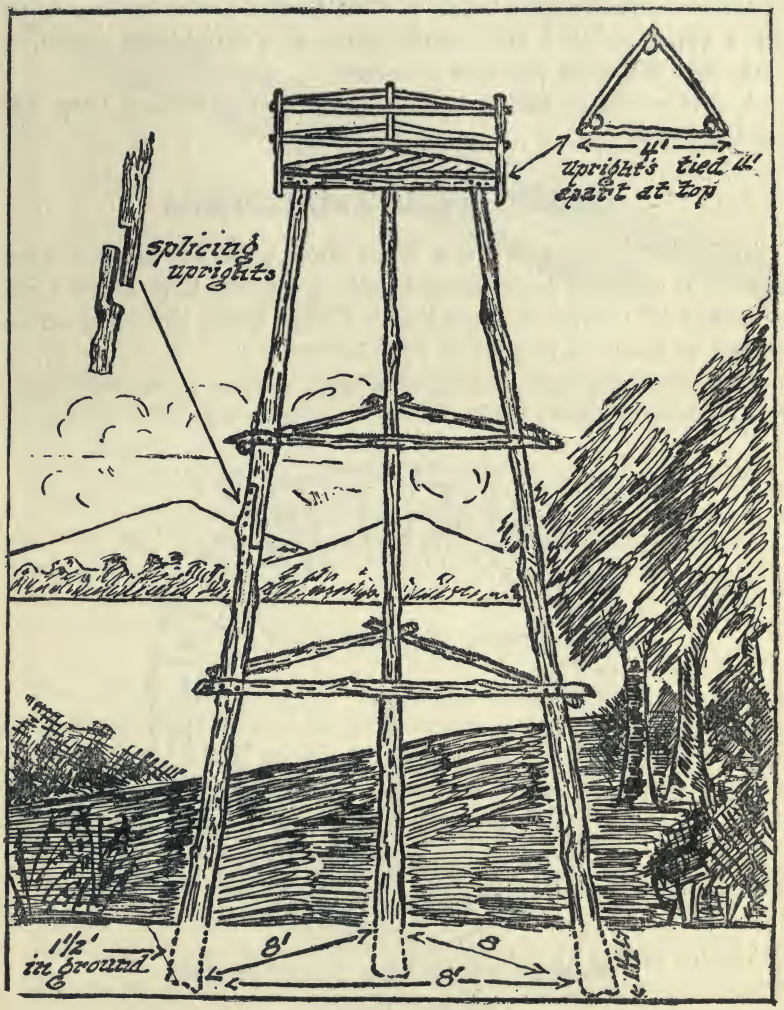


FIG. 19
Illustrating method of constructing signal tower

boards or else straight limbs of trees spiked to the cross girders. At a distance of 5 feet apart cross ties should be spiked to make the tower as rigid as possible.

A row of cleats nailed to one of the uprights does very well for the ladder.

SECRET CODES AND CIPHERS

Both the Army and Navy have their code books, which are especially adapted to military needs and insure both secrecy and economy of words in signaling. These codes are confidential except to those in service of the Government.

The land telegraph and cable companies also issue code books from time to time to their customers, not so much for the reason

SECRET CIPHER DISC USED BY THE SIGNAL CORPS

FIG. 20

FIG. 21

of secrecy, as for economical benefit of the messages. These code books can sometimes be obtained and will serve very well for all classes of signals.

So the boy signalman will not be handicapped for the want of a secret code, the writer will suggest the cipher disc which is used by the signal corps and another improvised method of using the cipher.

THE CIPHER DISC

The cipher disc used by the signal corps is a simple but ingenious device pictured in drawing on opposite page. It consists of two circles of cardboard, one smaller than the other. These are joined at center so as to revolve. The inner circle is lettered around the edge with small letters and the outer circle with capital letters of the alphabet.

The alphabet reads from right to left on outer circle and left to right on the inner circle.

The letter **A** on inner circle indicated by the arrow is the key letter to the cipher. The purpose of this cipher is only to transpose one letter of the alphabet for another, thus the message **WE BREAK CAMP AT SUNRISE** when read from the disc

pictured would be sent and received as: **JB EOBFV DFTQ FM NLSOXNB.** It is of course understood by reader that the letter **F** would have been agreed upon by the sending and receiving stations prior to time this message was sent.

Any letter can be agreed upon between sending and receiving station and then the key letter **A** is set opposite on disc to encipher the message.

All numbers are spelled out when sent in a cipher message.

It is apparent to the reader that this method is not absolutely unreadable to any one who would take the time to figure out the key; however, when used in connection with a code, it can be made much more complicated to any one desiring to read your message.

The above method of sending cipher could be used with the General Service Code which was in existence prior to the adoption of the International Code of dots and dashes.

The old General Service Code is written as follows:

A—22	J—1122	S—212
B—2112	K—2121	T—2
C—121	L—221	U—112
D—222	M—1221	V—1222
E—12	N—11	W—1121
F—2221	O—21	X—2122
G—2211	P—1212	Y—111
H—122	Q—1211	Z—2222
I—1	R—211	&—1111

tion—1112
ing—2212
end of word—3
end of sentence—33
end of message—333

FIG. 22

The foregoing code is used with the various signal systems as follows:

Wigwag or single flag—one would be to right and two to left, three would be expressed by the front motion.

Ardois System—one would be red light and two white light, a space would be made for end of word, etc.

Sound System, by whistle, bell and foghorn—one would be indicated by a short blast or taps and three likewise.

Telegraph, Wireless and Flash Light System—one would be made by one click, buzz or flash, two by two clicks, buzzes or flashes and three made in same way using three.

HOW TO MAKE A CIPHER OUTFIT

A practical, yet simple cipher can be made by first obtaining several pieces of ordinary flat picture moulding like those shown in Figure 21. These pieces will slide parallel to each other; one piece should be at least 14 or 15 inches in length, while the other can be just half that length.

Next take white ruled paper and paste along flat surfaces of moulding, the ruling or lines of paper should be about ¼ inch apart.

Fifty-two spaces are necessary for the long piece and the alphabet is written twice, backwards, in small letters, starting from top as shown in Figure 22, these letters are numbered from 1 to 52.

The short piece of moulding is lettered with capitals starting with **A** at top, going down or the reverse of the lettering on the longer piece, which starts at bottom going up.

The number 10 on the small piece and the opposite number on the long piece are used as keys to cipher.

Method of Using Cipher Outfit. By referring to Figure 22 it will be seen at once that to change the cipher all that is necessary is to shift the small piece of picture moulding up or down. Each sending and receiving station would have this outfit handy, and to send a message the following procedure should be kept in mind.

Encipher or, that is, put your message into cipher from capitals to the opposite small alphabet.

To decipher a message at receiving station use the reverse method.

To give the receiver the proper key to cipher; this can be done by signaling the key in the preamble of your message; for example, the message: **"WE BREAK CAMP AT SUNRISE"** would be sent, if taken from Figure 22, as follows: (Key) 10—27 **QI LVIMC KMAX MT USZVEUI.**

Chapter VIII

MARITIME SIGNALING

United States Maritime Signaling is divided into two branches: that of the Merchant Marine and that of the Navy. The signal methods of the Merchant Marine apply in all cases to privately owned yachts, power boats and other small craft having use for a signal system.

To be well versed in Maritime Signaling it is necessary for a signalist to know wherein the methods differ between U. S. merchant vessels and ships of the U. S. Navy.

U. S. Merchant Marine Signaling. The methods of signaling in the U. S. Merchant Marine are based entirely on the International Code of signals, which is the result of many years of work on the part of the International Marine Conference.

The International Signal Book is used by all vessels throughout the world, both merchant and men-of-war, thus enabling all ships to carry on communications by signals, even without the knowledge of one another's language.

Every signal in the International Signal Book has the same meaning in any language.

Signals are sent from the International Signal Code by means of the following systems:

Flag Hoists, International Morse Code, which is same as General Service Code, International Flag Waving, Colombs Sound and Flashing System and International Distance Signals.

The most general method of signaling by vessels is by means of flag hoists in which the International Code flags are employed.

There is nothing that gives a poorer impression to expert signalmen, or those who know, than to observe the misuse of flags in signaling. For this reason the writer will acquaint you in a general way with a few nautical terms relating to flag hoist signals and correct form of handling flags.

FLAGS AND CORRECT WAY OF USING

The **Hoist** of any flag is the side fastened to flagstaff or line holding it.

The Fly of a flag is at right angles to the hoist. (See Figure 23.)

A Hoist of flags is a number of signal flags on one line or hoist.

The lines by which a signal flag or flags are hoisted are called **halyards.**

That part of halyard which is attached to upper hoist of flag running through pulley or block is termed the **down haul.**

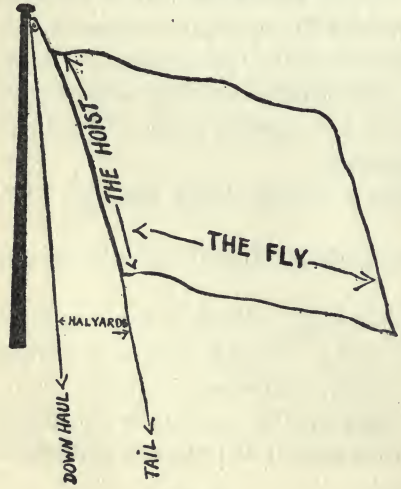


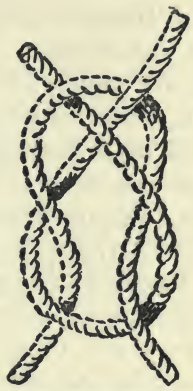
FIG. 23

That part of halyard which is connected to the lower hoist of the flag or flags is termed the tail. (See Figure 23.)

Flag signals on merchant ships are usually hoisted to the most convenient position on the yardarm or mast from which signals can best be seen and distinguished. However, on most of the larger ships a special signal

yard is used on the foremast which is situated ahead of the ship's funnels. The signals are not then obscured by smoke except in a case where receiving ship is dead astern.

Signal flags are flown from either **Port** (left side of a ship) signal yardarm, or **Starboard** (right side of a ship) signal yardarm according to position of the receiving ship.



SINGLE CARRICK BEND

FIG. 24

A flag is said to be **close up** when hoisted to its limit on a yardarm or mast and **at dip** when only hoisted two-thirds of the way up. (See Figure 25.)

The **Peak** of a mast is extreme top point. All signal and special distinguishing flags vary in size and shape; however, in regard to shapes, a way of classifying as to proper names can be found by consulting Figure 27.

Signal flags are fastened on the halyards by means of a ring at the upper end of the hoist of flag and a snap hook at lower end. They may be tied to halyards by means of a **single carrick bend.** (See Figure 24.) The last method is clumsy and slow. All of the up-to-date merchant lines and navies that have a great many signals to handle use rings and hooks.

FLAGS OF THE INTERNATIONAL CODE AND HOW USED

The International Code flags are twenty-six in number—one for each letter of the alphabet and also a code pennant, all of which are pictured on Chart 10. (See special section of colored flags.)

One-flag signals **B, C, D, L, P, Q** and **S** hoisted singly have a special significance. The code pennant over each indicates that they are signals of a general nature and of frequent use.

Code flags hoisted singly after numerals signal Number 1 refer to numeral table in Code Book, as do also two-flag signals with code pennant hoisted under them.

Two-flag signals without code flag are urgent and important signals; with the code flag hoisted over them they are time, latitude, longitude, barometer and thermometer signals. Three-flag signals express points of the compass, money, weights and measures and also other signals required for general communication. Four-flag signals with a **burgee** (**A** or **B**) uppermost are geographical signals; with **C** uppermost they are spelling or vocabulary signals; with **G** uppermost they are names of men-

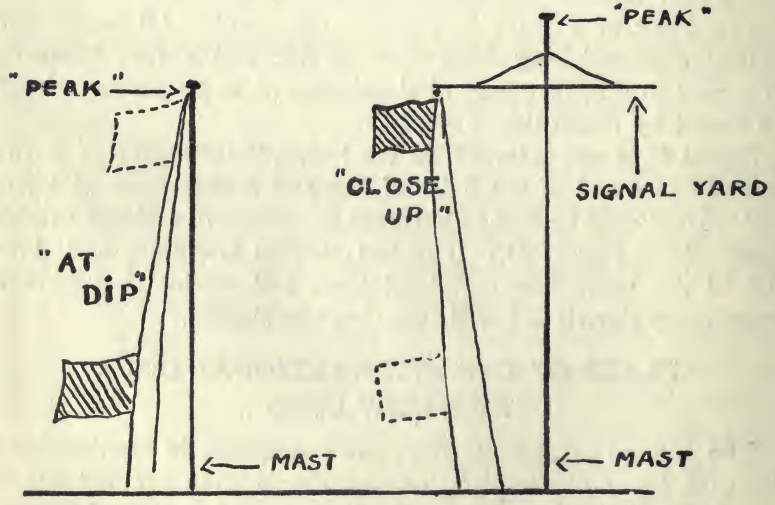


FIG. 25

of-war; with a square flag uppermost they are names of merchant vessels.

The following are meanings given single flags already mentioned:

B. Am taking on (or unloading) explosives.
C. Yes or affirmative.
D. No or negative.
L. I have (or have had) infectious disease aboard.
P. I am about to sail; all persons report on board.
Q. Have clean bill of health, but liable to quarantine.
S. I want a pilot.

Single flags are sometimes used as signals from a towing ship to ships in tow; the meanings when used thus do not, however, correspond in any way to above signals.

METHOD OF SIGNALING WHEN NO OTHER SHIPS ARE IN SIGHT

Example: Ship **A** wants to signal ship **B.** Ship **A** will hoist her ensign (national colors) over the code pennant but not on the same halyard. If hoisted at same mast as succeeding signal the methods will interfere. As soon as ship **B** makes out the attention signal she will answer by hoisting the code pennant at dip; then ship **A** proceeds with signals, first hauling down the code flag, and when completed ship **B** acknowledges by hoisting the code pennant **close up** and leaves it there until ship **A** hauls down the hoist of signals after which she lowers it to **dip,** and awaits the next signal.

When ship **A** has completed her signals she hauls down the ensign and the other ship hauls down the answering pennant (code pennant).

All flag hoists are read from top down and never exceed four to the hoist.

In case several ships are in sight and ship **A** wishes to signal ship **B**, she will attract attention of **B** by either of two ways; the first, is to hoist **B** ship's distinguishing letters or, second, to hoist the two-letter signals which indicate direction the ship she wishes to call is traveling.

All vessels are supposed to display their distinguishing call letters when passing at sea.

DISTANT SIGNALS

When in consequence of distance, wind or weather preventing the code flags from being seen, an alternative method of signaling is used, which is known as distant signals.

There are three ways of making distant signals:

1. By means of the Fixed Coast Semaphore.
2. By means of square flags, pennants and whefts.
3. By means of cones, balls and drums.

Calm weather and when wind is blowing from and towards the receiving station are the reasons that make it difficult to make out the colored flags of the International Code. For this same reason the method of distant signaling by means of square flags, pennants and whefts is not as preferable as by the cones, balls and drums. A wheft is any flag tied in center to halyards; therefore this system is mostly used.

Chart 15 gives the distant signal alphabet by balls, cones and drums.

The shapes are made by stretching canvas over pieces of light wood or metal forms, the canvas is as a rule then painted black.

The signals are made from International Signal Book and hoists are read from top down same as the flags.

DISTANT SIGNAL ALPHABET

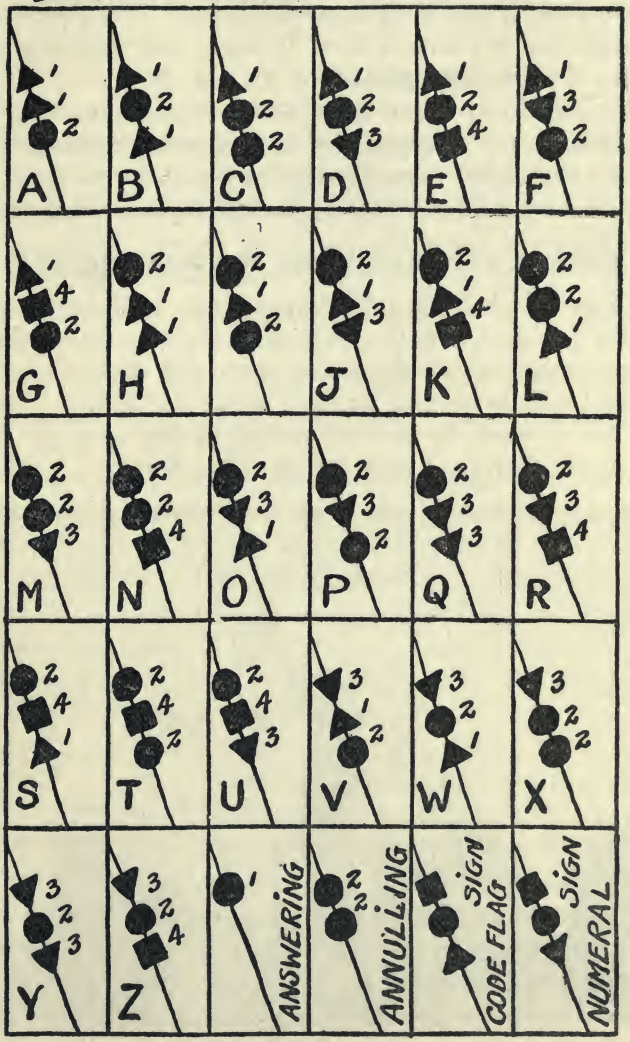


CHART 15

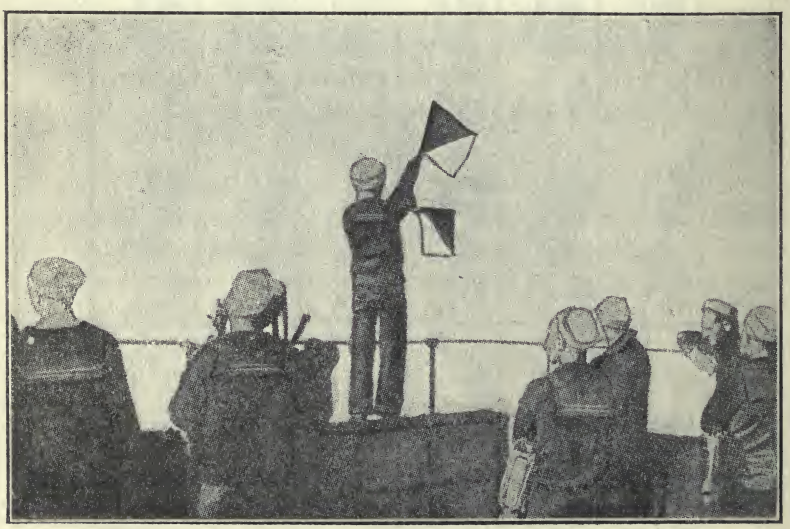
For convenience in their use the shapes representing the letters have been arranged in numerical order. The letters **A** to **G** begin with one, the letters **H** to **U** begin with two, and the letters **V** to **Z** begin with three.

Distant signals by Fixed Coast Semaphore are made by a semaphore machine. The position of the arms indicate numbers which are translated from the International Signal Book. This method is only employed by shore stations and not by ships.

INTERNATIONAL FLAG WAVING SYSTEM

The International Flag Waving System is done by a single stick wigwag flag and the International Morse Code is used. However, the method of making dots and dashes is different from the U. S. Army and Navy Wigwag System.

The dot is made by a short sweep of flag over the head of sender and a dash by a long swing of the flag.



Chapter IX

U. S. NAVY FLAG SIGNALS

The flag signal system of the Navy is in all probability the most important of all day signal methods. It has the advantage over the two-arm semaphore, either hand flags or machine method, and the wigwag which are the other day systems used by the Navy and which have already been explained.

The advantage of flag signals in the Navy is the great range and its adaptability to fleet manoeuvering and battle tactics.

The flag signals are made by hoists transmitting the Navy Flag Code, this flag code can also be sent by all the other signal methods used in the Navy.

When flags are necessary for intercommunication between the U. S. Army and all merchant ships, the International Flag Code is used.

The term "break" or flag is "broken" will come up in connection with Navy flag signaling, so it will be well to acquaint you with the proper way of making up a signal flag for breaking.

There are several ways to do this, but the following plan, if followed, will prove the most reliable:

Figure 26 (A) shows a signal flag lying flat on the deck ready to be made up for the "break." To do this the flag is folded on dotted lines 1 and 2 and then rolled towards the hoist as in B, after which the tail line is laid on top of rolled flag in form of a loop. The free end of line is then wrapped securely around the roll and over the loop by a number of turns and again looped into the end of other goose neck (see C) and drawn tight, which serves to clinch the tail line.

The flag is then ready to hoist as in D, after which it can be broken by simply giving a sharp tug on the tail line.

The foremast is principally used for signaling by naval ships, except in the case of a flagship which flies her signals from the

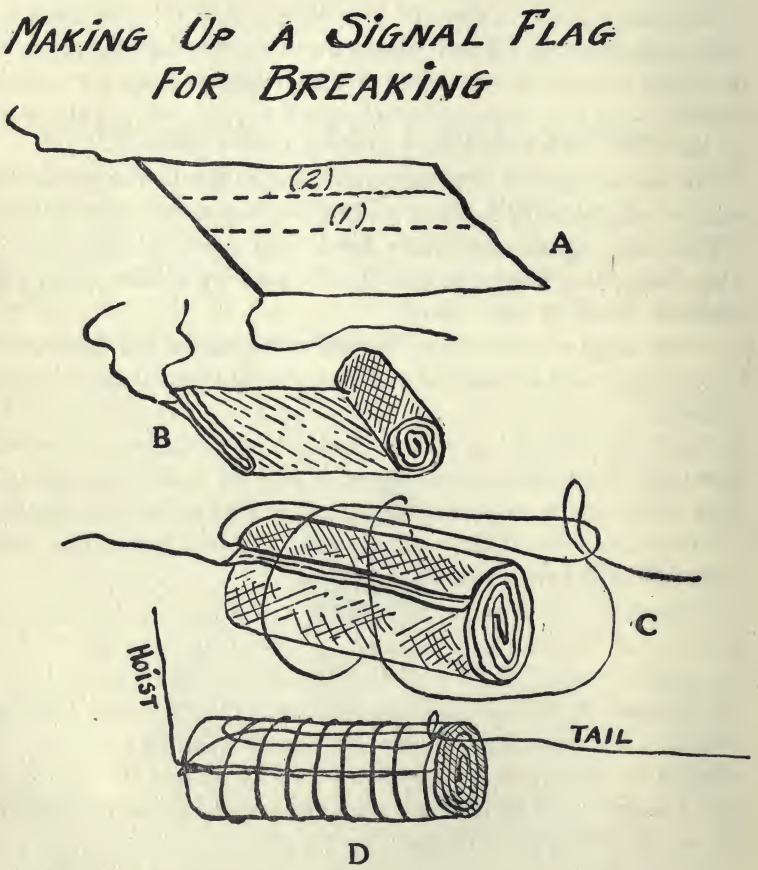


FIG. 26

main mast. The signal yards in either case are usually provided with three to six signal halyards on each port and starboard side.

The peak of a mast on a naval ship is usually termed the truck.

HOW NAVY SIGNALS ARE EXECUTED

The General Signal Book of the U. S. Navy contains a list of signals known as the Navy Flag Code. This book is divided into various parts, some of which are very confidential and are in the hands of only the higher officers.

The method of making the signals is alike no matter from what section or volume, as the meanings are arranged in alphabetical order opposite the signals to be sent.

The flags and pennants used in the Navy for making flag signals are the alphabet flags of the International Code flags, except the code pennant (see Chart 10) and a number of special flags and pennants contained in Charts 11 and 12.

While the alphabet flags of the Navy Code are same in design as those of the International Code, they have no connection whatever. A distinct naval feature is to call the flags by name rather than by letter, the name applied to the alphabet flags are able for **A**, boy for **B**, etc., same as the conventional signals used for telephoning on page 66.

CALLS

Each ship in the Navy is furnished with a call, which is a combination of two letters like **ZL**, **PN**, or **AD**.

For sake of convenience the first letter of a ship's call represents the group to which that ship belongs and the second letter the ship of that particular group.

One set of flags is used for the group and another for the ship.

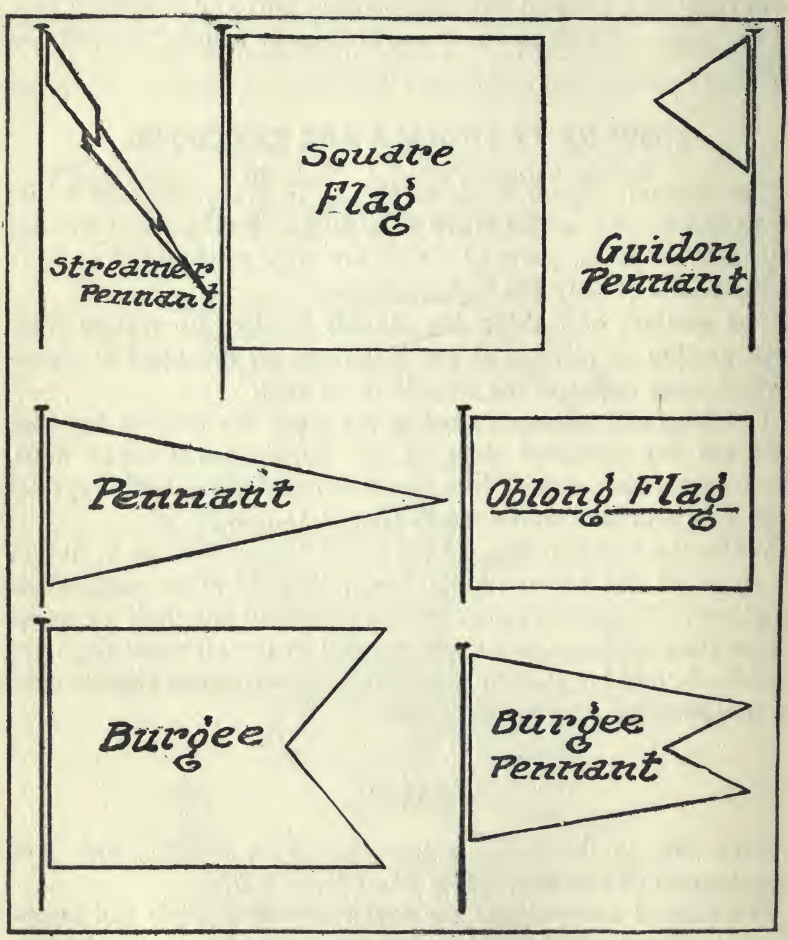

Streamer Pennant
Square Flag
Guidon Pennant
Pennant
Oblong Flag
Burgee
Burgee Pennant

FIG. 27

The two-letter call of each ship is made by using one of the **call flags** and one of the **call pennants.** (See Chart 11.)

In order to furnish calls to squadrons, divisions, etc., of a fleet additional flags are used for indicator flags and will be found on Chart 12 under the title, Squadron, Division, Torpedo Flotilla and Submarine Flotilla.

The call of a particular ship wanted to take a message would be made (in case of a number of naval ships of various classes in immediate vicinity) by its indicator flag with call letters hoisted underneath.

Where a general call or message is to be given to all ships within signal distance, the cornet flag is hoisted without individual call letters and all ships are required to answer.

All naval vessels passing at sea always hoist their call letters. The answering pennant is used to answer all flag signals, and is hoisted from point best seen (at truck or either side of the signal yard) and is kept there until ship signaling hauls down the signal. The answering pennant is also used as a divisional point in making a numeral hoist.

The alphabet flags from **Q** to **Z** are designated as numerals from **1** to **0** respectively and are so indicated when the numeral flag precedes them on a hoist.

The repeaters 1st, 2d and 3d serve to reproduce numeral hoisted above them. The first repeater would act as a repeater for the first flag, 2d repeater for second and so on. For example, the numeral 232 would be hoisted using the numeral flag followed by R(2), S(3) and first repeater.

The numeral 2222 would be hoisted R(2) 1st, 2d, and 3d repeaters.

The Preparatory Flag (L) means prepare to execute signal shown. It is also used as a time signal by the flagship or senior ship present, in which case it is hoisted at 6:55 A. M. and hauled down promptly at 7 A. M. It also indicates that the

uniform of crew is same as yesterday. When hoisted at 7:45 A. M. over a numeral it indicates the size of the ensign (colors) ships are to hoist at 8 A. M. It is hauled down at 8 A. M. and all ships then hoist the national colors.

The Interrogatory Flag (O) hoisted over a signal changes its meaning into the interrogatory form.

The Affirmative Flag (P) when hoisted in answer to a signal means yes, or permission granted.

The Negative Flag (K) when hoisted in answer to a signal means no, or request not granted.

The Annulling Flag (N) annuls all signals at time display on the same mast, hoisted alone it annuls a previous signal which has just been made.

The Quarantine Flag (Q) hoisted at foremast truck indicates ship is under quarantine or has an infectious disease aboard.

The Guard and Guide Flag, when hoisted at fore truck in port between sunrise and sunset, indicates that that ship is charged with the guard duty for that day (a red truck light is used at night at foremast).

When hoisted by a ship under way it indicates that that ship is to guide the formation.

The guard flag is displayed on all the small boats belonging to the ship doing guard duty. The guard flag, however, is not displayed in any way by a flagship if they are performing that duty.

The Convoy and Position Pennant is worn at the foretruck of all ships on convoy duty; in formation, when hoisted at dip it signifies "I am temporarily out of position."

The Danger and Designating Flag hoisted alone means danger ahead; a compass signal under it signifies the direction from which danger is expected.

The Dispatch and Breakdown Flag (I) when worn at main truck indicates that that ship is on dispatch duty; in fleet formation this flag is always kept rounded up ready to "break" at

foretruck and when "broke," it signifies a breakdown of ships machinery or the steering gear. In case of a man overboard it is "broken" and lowered at dip.

The General and Boat Recall Flag. Hoisted alone this flag calls all the small boats back to their respective ship at once. When hoisted under a number it recalls only that boat or boats having these numbers. At night small boats are recalled by the display of I followed by boat numbers and the call letters of ship signaling.

The Powder and Firing Flag (B) is displayed at the foremast of all naval vessels engaged in taking on board explosives, such as loaded shells, fuel oil or gasoline.

The Meal, Full Speed and Flag Officer Leaving Pennant, when hoisted singly at the port yardarm by a ship at anchor, signifies that crew is at meal; if hoisted at sea on same yardarm with the speed cone, it means one knot faster than standard speed; alone with speed cone it denotes full speed; and when hoisted under the flag of any flag officer it conveys the fact that that officer is leaving the ship.

The Battle Efficiency Pennant is shown at the foremast (when ship is at anchor) of ship or ships which are authorized to fly same. The Battle Efficiency Pennant is awarded each year by the Navy to one ship in each of the battleship, submarine and torpedo boat class for excelling in gunnery and engineering for that particular year.

The Church Pennant is hoisted over the ensign while divine services are being held, it is the only flag ever hoisted over the ensign for any reason whatsoever.

The Red Cross Flag is an International flag flown by all hospital ships, their small boats and also flown at Naval Field Hospitals. The flag is flown at the bowstaff on ships.

The Submarine Warning Flag is hoisted and flown by any vessel or small boat acting as a mother ship or fender to sub-

marines, and it signifies that submarines are submerged or operating in that vicinity.

U. S. NAVAL FLAG ETIQUETTE

Every ship in the U. S. Navy carries a complete set of the various national ensigns of other countries. Some nations have two ensigns, each different in design, one for men-of-war and another for merchant vessels. In the case of the United States government the national colors are alike for both naval and merchant ships.

The national ensigns of foreign countries are flown from the main mast of U. S. Naval vessels on occasions such as a visit from the head of a foreign government or any other high officials, either diplomatic, military or naval. In American or foreign waters, on occasion of such a visit, the national ensign of the country the official represents is made up and "broke" at main mast as the visitor or visitors step aboard. At time flag is broken the saluting battery fires the proper salute that the visitor is entitled to.

U. S. Naval ships upon entering a foreign port always "break" the national ensign of the nation visited and fire a salute of twenty-one guns. The salute is answered by the highest official present from either a naval vessel or a military shore station or fort.

U. S. Naval ships passing other men-of-war or merchant ships at sea always dip the colors in answer to the same courtesies. It is customary for merchant ships of either U. S. or foreign countries to dip colors to the men-of-war first. However, in case of naval vessels meeting, the junior officer always dips first to his senior. No salutes are fired as a rule to naval officers of a rank lower than a flag officer, which in the U. S. Navy is a Rear Admiral or above in rank, except where an officer lower in rank may be acting in that capacity.

TIME FOR FLYING COLORS

The time for flying of the national ensign on naval ships is given by the senior officer present. The size of colors to be used is also designated by signal. As a general rule the colors are hoisted at 8 A. M. in port and at the flagstaff at stern of ship with the proper ceremonies. At sea the colors are hoisted at the gaff (small spar projecting from the main mast). The colors are lowered at sunset with the same ceremonies, but at sea the colors are usually replaced after being lowered by a smaller ensign which flies all night, as do certain other special designator and personal flags. It is not customary to signal by means of flags before morning or after evening colors.

The Union Jack is hoisted in port only and at jackstaff in bow. It is hoisted at morning colors and lowered at evening colors. The Union Jack hoisted at fore signal yard indicates there is a general court martial or court of inquiry being held aboard. When hoisted for such purposes a gun is fired. The Union Jack hoisted at foremast truck calls a pilot aboard.

PERSONAL FLAGS

Chart 13 gives the personal flags of the higher officers in U. S. Navy, along with special distinguishing flags of the naval militia and yachts.

The President's Consular and flags of Secretaries of the Navy are used on any visit to a naval vessel by these officials.

The personal flags of Admiral, Vice Admiral and the Rear Admirals are flown at the main mast truck of their respective flagships.

The Blue Pennant of Senior Officer present is known by the ship having the senior officer of any group of naval vessels in the absence of a flag officer.

All naval ships in commission fly the commission pennant at

the main mast truck. This pennant really acts as a personal flag of the commander of the ship and in case of a flagship it is not worn, as the flag officer's personal flag signifies that that ship is in commission.

The Naval Militia Distinguishing Flag is worn at foremast truck of all naval vessels loaned by the Navy department to a state for use of Naval Militia or Naval Reserves when such vessels are under command of Naval Militia or Reserve Officers. The Naval Militia Commission Pennant is worn at main mast truck on such ships, and in event of ship having a flag officer aboard his personal flag is flown instead at main truck. The rank of Commodore is the highest in Naval Militia.

YACHT FLAGS

It is required by law that all pleasure yachts and boats of more than 15 tons display the yacht ensign. This you will note by referring to Chart 12 is different in design from the national ensign and serves to signify when worn that that particular ship is a pleasure boat.

Yachts fly all personal flags in a similar way as used in Navy. For signaling, they use all navy methods except Navy Flag Code. The substitute being the International Flag Code for flag hoist signals.

Chapter X

MISCELLANEOUS SIGNALS

INTERNATIONAL LIFE SAVING SIGNALS

1. Upon the discovery of a wreck **at night,** the life-saving shore station burns a red light or sends up a red rocket to signify "You are seen," assistance will be given soon as possible.

2. A red flag waved on shore **by day** or a red light or red rocket **by night** means "Haul away."

3. A white flag waved on shore **by day** or a white light waved slowly or white rocket **by night** means "Slack away."

4. Two flags—a white and a red—waved at same time on shore **by day,** or two lights—a white and red—swung slowly or a blue light burned **by night** signifies "Do not attempt to land in your own boats, it is impossible."

5. A man on shore beckoning **by day** or two torches burning closely together **by night** will signify "This is the best place to land."

SIGNALS FOR A PILOT

Any of the following when displayed from a ship will call a pilot:

1. The Jack, hoisted at the foremast.

2. The International Code pilot signal indicated by the alphabet letters **P T.**

3. The International Code flag **S** displayed alone or with code pennant over it.

4. The Distant Signal, with cone pointed upward, having above it two balls or oval shapes.

5. At night, a blue light burned at intervals of about fifteen minutes or a bright white light flashed at short intervals just above the deck.

6. To signal for a tow boat place the National Ensign in main rigging just above the decks at intervals of one minute at a time.

INTERNATIONAL DISTRESS SIGNALS, FOR DAY

1. A gun or other explosives fired at intervals of one minute.
2. The International Code letters N C.
3. Fog Signal apparatus sounded steady.
4. The Distant Signal consisting of a cone pointed upward, having either above or below it a ball or oval shape.

INTERNATIONAL DISTRESS SIGNALS, FOR NIGHT

1. Gun or other shot fired every minute.
2. Flames of a burning tar or oil barrel.
3. Rockets or shells throwing stars any color at short intervals.
4. Foghorn sounded steady.

The United States Weather Bureau is operated under the Department of Agriculture. The Bureau has many stations throughout the country as well as 142 stations on the Atlantic and Gulf Coasts and 46 stations on the Pacific Coast.

Weather predictions are given out from these stations to all the newspapers, and bulletins are furnished to all Federal buildings for posting.

The inland stations have telegraphic connections with the coast stations and inform them of the approach of severe storms. The coast stations in turn notify mariners by means of flag signals and radio.

All the civilized nations of the world maintain a similar system in which their coast stations give information to ships.

The Weather Signal flags may be seen by turning to colored Chart 14; at bottom of same chart are storm and wind signal flags, along with night lantern signals.

The Weather and Storm Signal flags when displayed on a flag pole are arranged to read from top down. When single hoists of several flags are made on a signal yard a small streamer is used to indicate the point from which signals are to be read.

Temperature forecasts signals are made by using the weather flags, five in number—four square flags and one pennant.

The flags are displayed at weather bureau stations as follows, and indicate weather predictions for next twenty-four hours, commencing at 8 P. M. of day the signals are made:

1. Square white flag indicates clear or fair weather.
2. Square blue flag indicates rain or snow.
3. Square flag white on upper half and blue on lower half indicates local rains or showers will occur and that rainfall will not be general.
4. Square white flag with black square center indicates the approach of a sudden and decided drop in temperature—a cold wave.
5. Black pennant is used to refer to temperature and has no meaning hoisted alone. In no case is it ever hoisted with the square white flag with black center. (Cold wave flag.)

The black pennant hoisted above square white flag, blue flag and white and blue flag indicates warmer weather along with the regular indication that that flag stands for. When hoisted below any of these flags it means **colder weather.**

Storm and Wind Signals. The warnings adopted by the U. S. Weather Bureau to announce the approach of wind storms are as follows: (See bottom of colored Chart 14.)

The Small Craft Warning. A red pennant indicates that moderately strong winds that will interfere with the safe operation of small craft are expected. No night display of small craft warnings is made.

The Northeast Storm Warning. A red pennant **above** a square red flag with black center displayed by day or two red lanterns, one above the other, displayed by night indicates the approach of a storm of marked violence with winds beginning from the **northeast.**

The Southeast Storm Warning. A red pennant **below** a square red flag with black center displayed by day or one red lantern displayed by night indicates the approach of a storm of marked violence with winds beginning from the **southeast.**

The Southwest Storm Warning. A white pennant **below** a square red flag with black center displayed by day or a white lantern **below** a red lantern displayed by night indicates the approach of a storm of marked violence with winds beginning from the **southwest.**

The Northwest Storm Warning. A white pennant **above** a square red flag with black center displayed by day or a white lantern **above** a red lantern displayed by night indicates the approach of a storm of marked violence with winds beginning from the **northwest.**

Hurricane or Whole Gale Warning. Two square red flags with black centers, one above the other, displayed by day or two red lanterns, with a white lantern between, displayed by night indicates the approach of a tropical hurricane, or one of the extremely severe and dangerous storms which occasionally move across the Great Lakes and Atlantic Coast.

Chapter XI

HOW TO MAKE SIGNAL APPARATUS

Flag Making. The most suitable material for flag making is either galatea or calico. The color and dimensions of the cloth are dependent upon type of flag wanted and the size.

The tools necessary are a straight-edged yardstick or ruler, a soft pencil or chalk for marking off the cloth, an old safety razor blade or a pair of scissors for cutting and needle and thread for stitching flag together. You can get your mother or sister to do all sewing required on the sewing machine.

Making Wigwag Flags The standard dimensions of the wigwag flags used by the Signal Corps are the **3-foot, 9-inch square flag with 12-inch square center** and the **2-foot square flag with 8-inch square center.**

The 2-foot size flag is large enough for most signaling and it will be best for you to adopt this size or possibly smaller as the larger type is only useful in case of extreme distances. The 12-foot staff necessary to carry a flag this large is very hard to handle.

The 2-foot wigwag flag needs a staff 5½ feet in length. If flag is made smaller than this the staff can be made shorter and the center square can be cut down to a proportionate size.

The color combinations for wigwag flags are turkey red and white, or scarlet and yellow. Blue and white is sometimes used and is very good, but red and white is the best.

Flags can be made up using any of above combinations, alternating the colors of the body of the flag and center for use against different backgrounds.

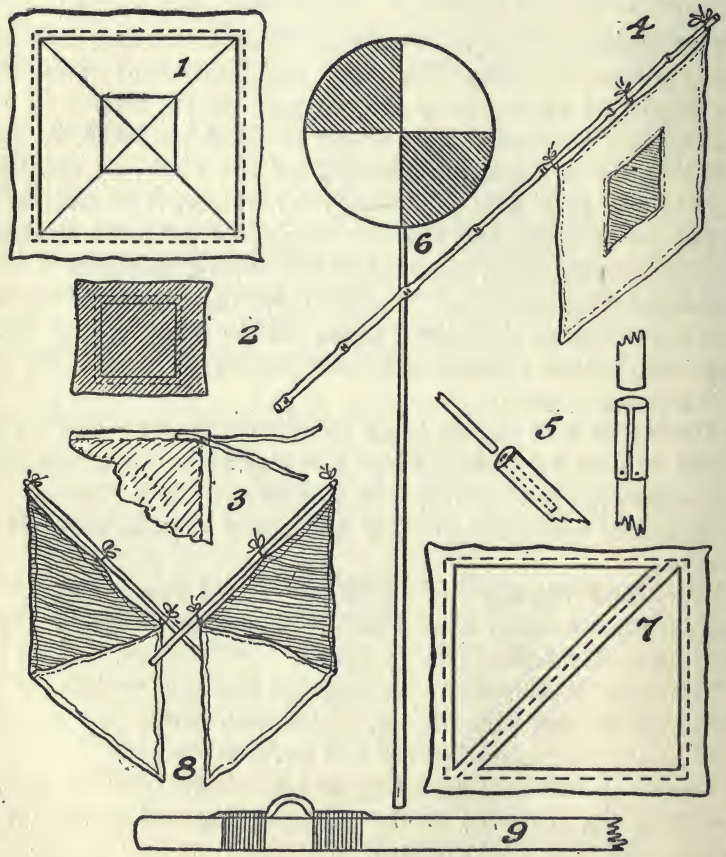


CHART 16.

No. 1 of Chart 16 shows the proper way to lay out a wigwag flag. The cloth can be tacked to any flat surface and, with a ruler and pencil, a square can be marked off the exact size wanted. Lines can then be drawn from corner to corner as shown. This serves to help get the square in the exact center. The cloth can then be cut around the dotted lines, which should be about ¼ or ½ inch from edge of flag. This gives enough margin for hemming. The next step is to turn down the edges of flag and pin. A selvedged edge can then be made by hemming on a sewing machine or stitching by hand. After this is done another small piece of cloth of opposite color is marked off as pictured in No. 2. The size of square being same as the square in center of flag. The smaller piece of cloth is then cut around on the dotted lines and hemmed around the edge, after which it is placed over the square of the larger piece of cloth and sewed on. Be careful to stitch as close to edge as possible. After this the flag can be turned over and cut out on inside of stitching with a pair of scissors. This brings the square through and makes flag the same on both sides. The flag is now complete except for a staff and the fastenings necessary.

Ties can be sewed on flag as shown in No. 3, using flat binding tape. Three ties will be enough—one in center and one at each end, as seen in No. 4 on the completed flag. For a staff a bamboo fishing pole can be used or any round pole of ¾ to 1 inch in diameter.

No. 5 suggests several ways of making a jointed pole if one is wanted to make flag staff convenient to carry on a hike.

THE WIGWAG DISC

No. 6 suggests a disc for wigwagging. The disc can be either cut out of a piece of tin or heavy cardboard, painted in colors black and white or red and white and then tacked to a

slender stick or pole. This piece of signal apparatus is easily made and has the advantage over the flag on a windy day as flag is very apt to foul while the disc is not open to this objection.

SEMAPHORE FLAG MAKING

Semaphore flags can be made exactly like wigwag flags except for size, which vary from the 10 and 15-inch sizes used in Navy to 24-inch size which is the largest used by the Army.

For all around semaphore signaling the 12 to 18-inch size will be found most adaptable. The flags are always made square in shape and usually of a design like the wigwag flags, with square center or the diagonal type illustrated. (No. 8.)

No. 7 shows the way to mark off cloth for cutting out the diagonal flag.

The ties for fastening flag to stick can be made the same way as in the case of the wigwag, but need not be as strong. The darkest portion of flag goes next to stick and the stick should be only long enough to allow a hand hold below the flag. The stick can be notched to keep ties in place; or another way which makes a neat effect is to make eyelets as shown in No. 9. This is done by shaping the eyelets out of a piece of copper wire, flattening the ends and binding them to the stick with fine wire or heavy thread, after which a coat of varnish, if added, will put on the finished appearance.

HOW TO MAKE A FIELD BUZZER OUTFIT

The field buzzer is an instrument used by Boy Scouts and armies for sending and receiving signals between temporary stations. It is strictly a portable instrument. The one used by the United States Army can be used for many kinds of signaling. It will work as a telephone or as a telegraph. Of course it is used as a telephone whenever possible; but when the connecting lines are broken, it is possible to use the sets as tele-

graph stations, and messages are sent and received in the form of a high pitched hum very much like that of a radio signal.

In actual field use, these messages have been sent and received when the lines were cut off but both ends of the line slightly grounded. It is not hard to make an instrument similar to the United States Service Buzzer which will give the Gilbert Signal Engineers lots of sport as well as practice in telephone and telegraph work. This amateur set will not, of course, be so elaborate as the army set, because the latter is made for use in all sorts of weather, in all sorts of places.

But for practice work, the little sets described below will serve you just as well and will be cheaper and easier to build.

TELEGRAPH BUZZER

This instrument can **not** be used as a telephone set, but can send and receive Morse and Continental Code telegraph messages.

SERVICE BUZZER

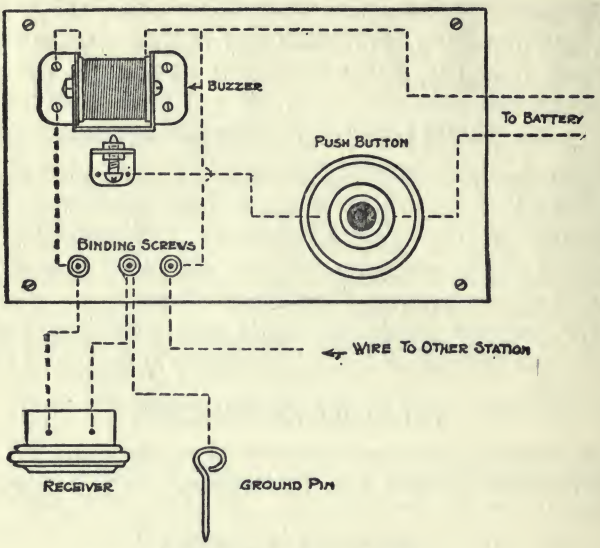
Parts Required

1. **Panel**—This should be about ⅛ of an inch thick and can be made of hard black rubber, black fibre, or even thin wood painted or stained to make it look well. This panel should be 6 inches long and 3½ inches wide.

2. **Battery**—Purchase five flash light batteries and connect them in series. The batteries used in the set described here measure 1⅜ wide, 11/16 inches thick and 2¼ inches long. But batteries of other size can be used if necessary, and the only change in the set required will be in the wooden box enclosing the set and in the size of the panel.

3. **Key or Button**—For this set an ordinary doorbell push button will do very well.

4. **Telephone Receiver**—Purchase a 75 ohm telephone receiver of the watch case type.



PANEL SHOWING COMPLETE ASSEMBLY
CONNECTING WIRES SHOWN DOTTED

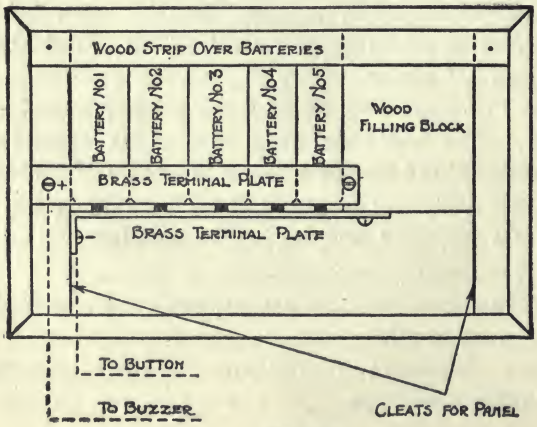


FIG. 28

5. Vibrator and Vibrator Coil—You can buy a buzzer such as is used for sending practice in wireless telegraphy, or, if you prefer to make one yourself, you will find the following instruction helpful.

Cut two cardboard or fibre discs; these should be about ¾ inches in diameter. Put a hole through the center 3/16 inches in diameter and two small holes for the wire to pass through as near the edge as possible and on opposite side of the large center hole. These small holes can be made with a small nail or an awl. (See Figure 29.)

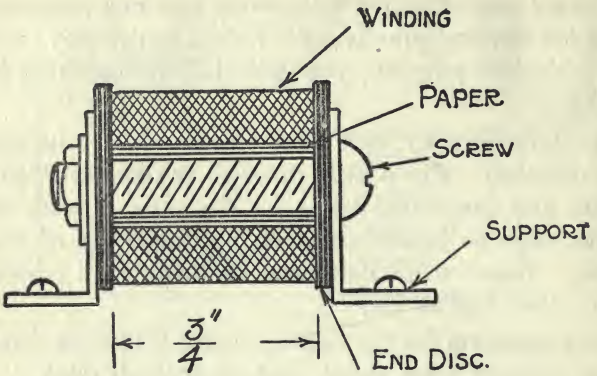
Make two supports for the buzzer, using 1/16 inch steel and a vibrator of springy steel about 1/64 of an inch thick.

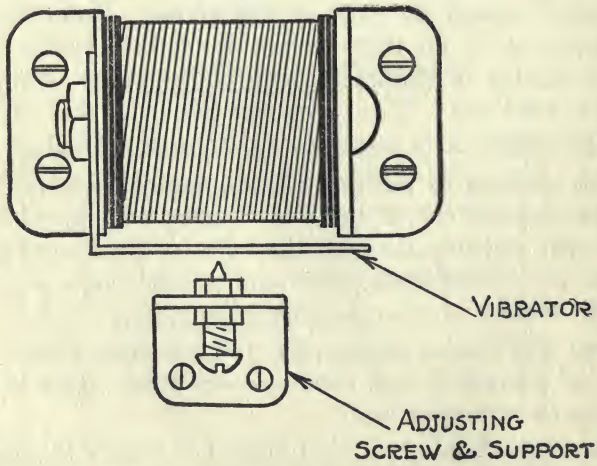
Place an 8-32 round head steel machine screw 1⅛ inches long through one of the supports and washers, holding the latter tightly against the screw head. Wrap six or seven layers of writing paper around the body of the screw. Make the width of this paper ¾ of an inch. Place the other washer on the screw and tighten it against the end of the paper wrapper, by means of a steel nut. Wind over the paper 25 feet of No. 24 B&S Gauge copper wire insulated either with enamel or cotton.

Start this winding by pushing a beginning of the wire through one of the small holes in the end washer, leaving about 2½ inches of wire sticking through the hole for a connecting lead. When the coil is complete, stick the end through one of the other small holes and your magnet is complete.

Next you will need a support for the adjusting screw, which should be of brass 8-32 and about ½ inch long. This is locked in place by an adjusting nut.

6. Box—This should be a well-made box with a hinged cover and clasp. (See Figure 30.) Make the inside dimensions of the box 6 inches long, 3½ inches wide and 2 inches deep. The cover should be 6 inches by 3½ inches by 1 inch deep. If you plan to



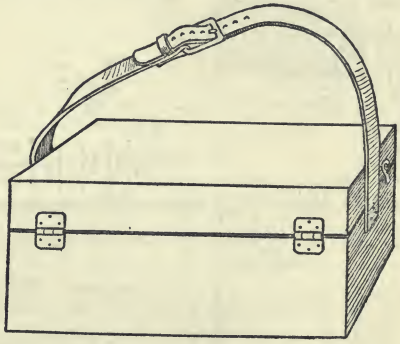


BUZZER SIDE & TOP VIEW

FIG. 29

use the buzzer on hikes, it will be well to put a carrying strap of leather or webbing on the box.

The batteries should be held in place by end blocks of wood and also by the two brass terminal strips shown in Figure 28. The battery terminals should be placed so they make good contact with these brass strips so that the first battery on the right



BOX COMPLETE.
FIG. 30

has the outside terminal against the upper strip, the next will have the outside terminal against the lower strip. Alternate these connections until all the batteries are in place.

Make the connections as shown in the diagram (Figure 28), fasten the panel in place, attach the telephone receiver to the binding screw and the instrument is ready for use. It will be a great help if you make an iron pin to push into the ground for one side of the line circuit. The other side should be a copper wire at least as large as No. 24 B&S Gauge.

BUZZER AND PHONE COMBINED

If in the above instrument we had used a telephone receiver connected, as shown in the next diagram (Figure 31), with this

circuit when the key is closed, a single click would have been heard in the receiver.

If the key is held down, no further sound will be heard unless some one speaks into the transmitter. The set will then act as a telephone. We will not take the time here to explain the telephone theory. It requires a book by itself.

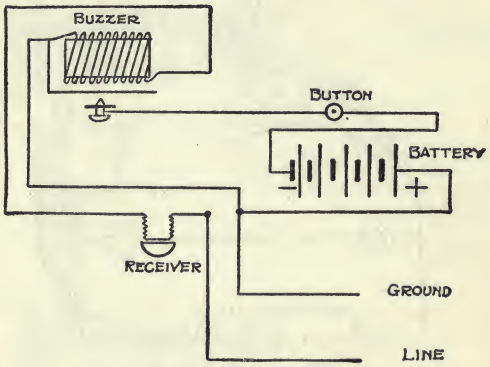


FIG. 31

Now we can combine the telegraph and telephone instruments in one by the addition of a second push button or key and a transmitter. Study the connection diagrams shown (Figures 32 and 33) and you will have very little trouble in understanding how to build this set.

When you wish to use this outfit as a telephone, you press Key No. 2, holding it closed. A current will then flow from the + side of the battery to the ground, from the ground it will pass through the grounded side of the listening station, around the buzzer winding, through the listening station receiver to the line back to the sending station, through the sending station receiver to the telephone transmitter, from the transmitter to Key No. 2 and from Key No. 2 to the battery, thus completing

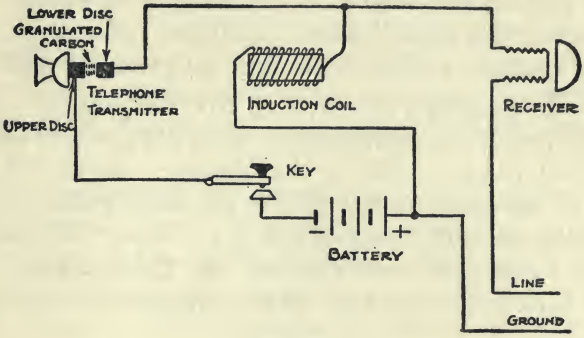


FIG. 32

the circuit. Note the whole battery is not used for this circuit but only two batteries are connected by a tap for the telephone use.

When the speaker at the sending station talks into the transmitter, his voice sets the little granules of carbon in motion, thus varying the resistance of the circuit. This causes the current to

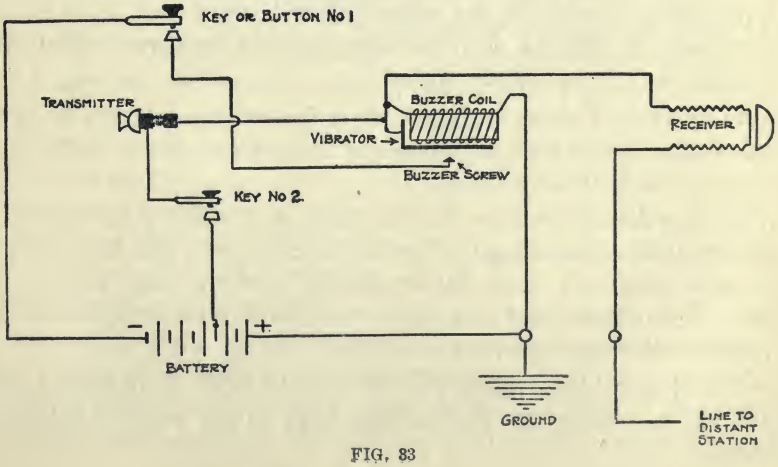


FIG. 33

fluctuate, causing the magnet in the receiver to vibrate the diaphragm for every tone the sender utters. This is heard as a telephone message by the listener at the receiving end.

To use the telegraph circuit, Key No. 1 is pressed. When it closes the circuit, the current flows from the positive side of the battery to the buzzer coil, to the vibrator. From the vibrator it passes to the brass contact screw, but at this point the circuit is rapidly opened and closed due to the action of the magnet and vibrator. From the contact screw, the current passes to the Key No. 1, from the key back to the negative side of the entire battery.

But in addition to this there is also a current flowing from the ground to the receiving station ground, through the receiving station buzzer coil, from the coil to the receiving station telephone receiver where a high pitched hum is heard, from the receiver to the line back to the line side of the sending instrument receiver to sending station buzzer coil and back to the ground.

When the sending station buzzer starts vibrating, it sets up a pulsating current in the second circuit which can be heard as dots and dashes in the receiving station receiver when the sending key is operated properly.

With two of these instruments it is possible for two boys to have lots of fun and, at the same time, learn many of the elements of electric signaling.

In the Army Service Buzzer there are other parts such as the condenser, so that the soldiers can attach the instruments to any telegraph lines in the country where they happen to be. This allows them to operate without interfering with the regular telegraph work of the line.

But these things make the set a little more complicated and are not necessary for the average boy, so we will not describe them.

HOW TO MAKE A HELIOGRAPH

Before trying to make the heliograph outfit illustrated on Chart 17 read over carefully the theory of heliographing in Chapter V, page 50, and with these principles thoroughly fixed in your mind the making and operating of the heliograph will be very easy.

To make heliograph as shown the station mirror and the two diaphragms (Nos. 2 and 3) are supported on a tripod, made by using a 2x4 or 4x4 inch upright. This can be sharpened and driven in the ground about 1½ or 2 feet, after which a 2x4 inch piece 6½ feet long can be fastened through the flat side at the center to the post by a large screw. This will allow the instrument to turn so as to face in any direction desired.

The station mirror can be made as pictured by using a plate glass mirror 4 inches square. The mirror is set in a frame made of picture moulding. The framed mirror is then mounted in a U-shaped easel. The easel can be made out of 1x1 inch lumber and strengthened by using small angle irons at corners. (These can be purchased at any hardware store.) The mirror frame can be suspended in the easel by attaching it to large size nails inserted in the holes that have been drilled through the center of the frame and the upright ends of the easel. A spring arrangement is then placed on each side of the mirror frame between the uprights of the easel. This can be worked out so that the mirror will set rigid at any angle.

The easel is bolted to one end of the tripod, using several washers on the bolt, between the 2x4 and easel. The station mirror can then be turned to right or left.

The diaphragms, Nos. 2 and 3, can be made out of tin, cardboard or light wood. Both of them can be made the same size, about 8x12 inches, with the 8-inch side at top. The diaphragms are cut out so as to slide on the 2x4 piece. They are balanced and supported by a piece of wood to which several

HOW TO MAKE A HELIOGRAPH

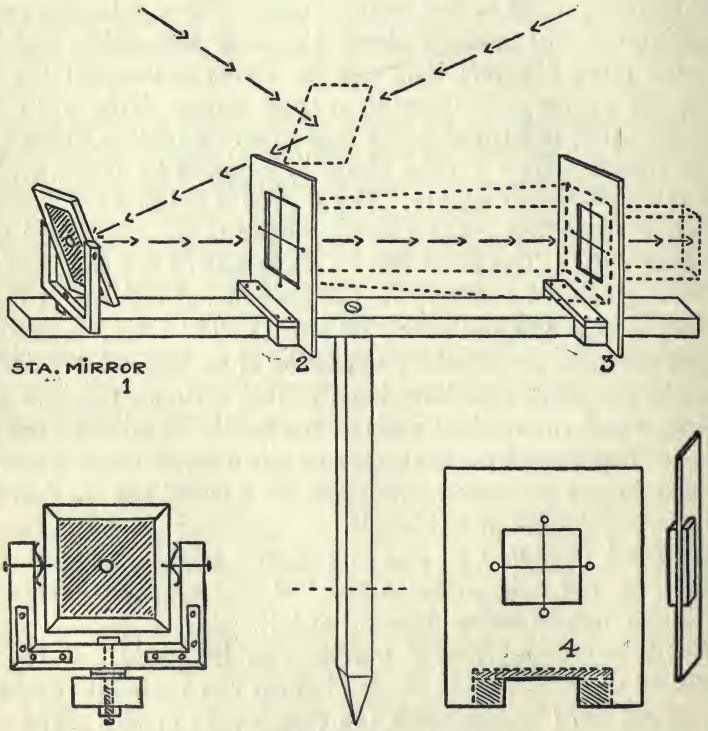


CHART 17

blocks are nailed on each side as shown. The diaphragm is of course tacked to the wood supports; this allows the completed diaphragm to slide on the 2x4 piece of the tripod.

The diaphragm shown in No. 2 has a square hole 3x3 inches at center, with cross wires. That shown in No. 3 has a square hole 2x2 inches, with cross wires or thread.

In making the diaphragms a great deal of care must be given to obtaining the right size hole in each and also that in the center of the station mirror. (Make the hole in the exact center of station mirror by scratching off a little of the silver.) The cross wires in each diaphragm must be exactly in line.

HOW TO OPERATE

The advantage of this type of heliograph over the open mirror type is that it reduces the beam of light down to a direct flash by means of the two diaphragms. The result of which is shown on Chart 17 by the dotted line which represents the straight course of the rays coming from the second diaphragm (No. 3).

The first diaphragm should be placed about 1 foot from the station and the second diaphragm (No. 3) about 3½ to 4½ feet distant from the first; as both slide they can be adjusted easily to the proper distance.

By lining up the receiving station through peep hole and cross wires of both of the diaphragms and the station mirror angled so as to catch the sun's rays, the apparatus is ready to send the message.

The flashes can be intercepted by using a piece of tin or wood about 12x12 inches square, to which several pieces of 1x1 inch wood can be nailed, as pictured at lower right hand corner of Chart 17. This gives a good hand hold and perfect control of your shutter.

An additional mirror will be necessary should the sun be behind the sender. The extra mirror can be held by another boy in this case so as to deflect the sun's rays into the station mirror.

A little practice will be necessary to get accustomed to the adjustment required when the angle which the sun's rays make with the mirror changes at different times during the day. When the knack of arranging the mirror is acquired you will have no trouble in sending a message up to twenty-five miles, if that distance is required with this outfit.

HOW TO MAKE A SEMAPHORE AND BLINKER

The semaphore at center of Chart 18 needs little explanation as it is simply two cross arms with paddles which can be painted in conspicuous alternating colors so as to be readable at a distance.

The post which carries the semaphore arms can be any height desired. The arms to which paddles are nailed should be made of 1x1 inch light pine wood and the paddles about ¼ or ⅜ inches thick by 2½ feet in length and 6 to 8 inches in width.

The semaphore arms are bolted or nailed below the other arms so as to fold back to post when not in use. This extra arm indicates to receiving station the sender's right or left.

Messages are transmitted by pulling the semaphore wings up by means of the cord to a position at right angles to the upright post and then dropping same immediately to a position parallel to and in back of the post.

The **right** wing when pulled up to the position mentioned will indicate the **dot** of the General Service Code and the **left** wing will indicate the **dash.** The end of word can be indicated by raising both arms at same time and the end of sentence by swinging the arms a little.

MAKING A SEMAPHORE AND BLINKER

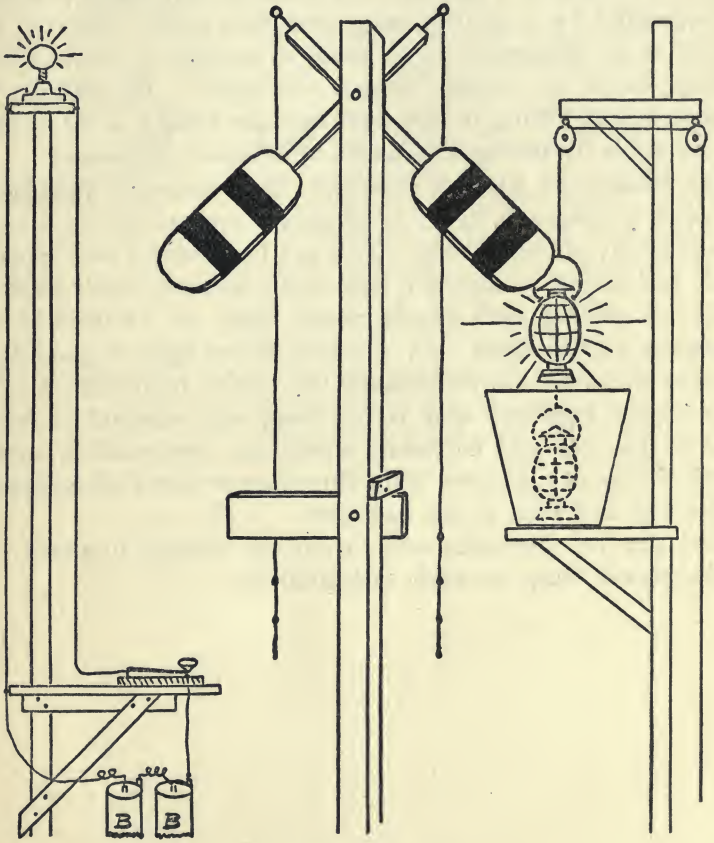


CHART 18

THE BLINKERS

Two types of blinker lights for sending messages by General Service Code are pictured on Chart 18.

The blinker at the right on the chart is made with a lantern and operated by a cord passing over two small pulleys. The lantern is so suspended as to make it possible to drop it in a bucket, which of course "douses the glim." By pulling the lantern up and letting it drop back into the bucket, a dot or dash can be made by timing the length of lantern's exposure.

The blinker on the left of Chart 18 is operated electrically by using a telegraph key. A miniature receptacle can be purchased at any electrical shop. This can be mounted on a wooden block and nailed to top of a pole or in fact any other suitable place. A small 2 or 3 candle power light can be used in the receptacle for the light. (A 3 candle power light is good for a distance of ¾ of a mile without the use of binoculars.) One light copper insulated wire is run from one terminal of receptacle to the dry cell batteries, which are connected in series. Another wire is run down from the other terminal of receptacle to the key and then to the batteries.

Two dry cell batteries will be strong enough to cause a 3 candle power lamp to work satisfactorily.

MEMORANDUM

MEMORANDUM

MEMORANDUM

MEMORANDUM

MEMORANDUM

MEMORANDUM

MEMORANDUM

MEMORANDUM

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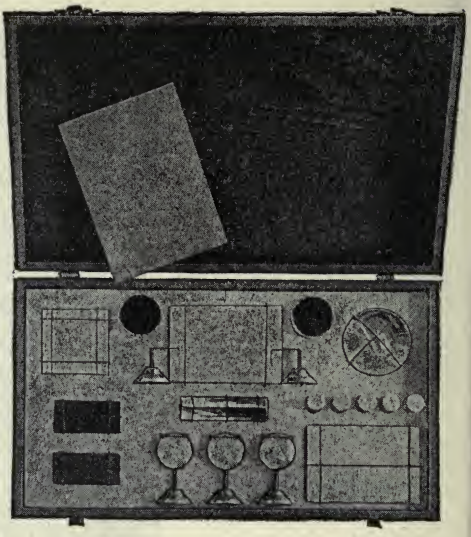

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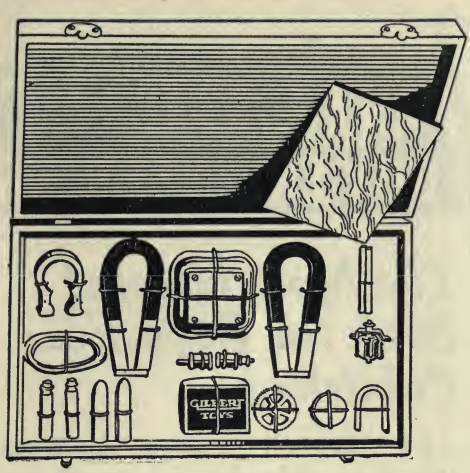

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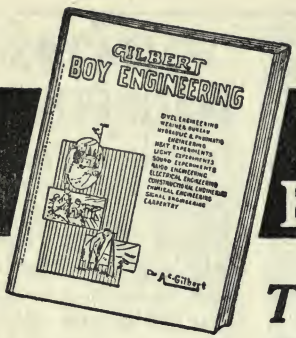

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